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ABSTRACT

This guide is part of a series designed to help students learn about technology and teachers organize and improve instruction in technology. The instructional materials are based on the curriculum-alignment concept of first stating the objectives, developing instructional strategies for teaching those objectives, and assessing to those same objectives. The unit activities relate to performing an energy audit, insulation, solving problems involving energy and power measurement, and constructing a pneumatic third-class lever. The teacher edition includes the following components: suggested activities, learning activities sheet, teacher supplements, an optional assignment sheet, an optional activities module, answers to assignment sheets, written test with answers, and unit evaluation form. In addition, the teacher edition includes information on use of the publication, a competency profile, an instructional and task analysis, academic and workplace skill classifications and definitions, and a related academic and workplace skills list. The student edition contains a unit of study on exploring energy, power, and transportation technology that includes the following components: objective sheet, information sheet, assignment sheets, laboratory activity sheets, and student supplements. (KC)

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Exploring Technology Education:

Exploring Energy, Power, and Transportation Technology

Teacher Edition

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Exploring Energy, Power, and Transportation Technology

Teacher Edition

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Foreword

Exploring Technology Education: Exploring Energy, Power, and Transportation Technology is one of five new publications that have been developed to replace MAVCC's original technology education series. The titles of the five new books in MAVCC's current technology education series are

- *Introduction to Technology Education*
- *Exploring Communication Technology*
- *Exploring Manufacturing Technology*
- *Exploring Construction Technology*
- *Exploring Energy, Power, and Transportation Technology*

The changes in the instructional materials in MAVCC's new technology education series reflect the changes that have occurred in industry as a result of emerging technology and the demand for more highly skilled workers who can read, write, find and interpret information, think creatively to solve problems, and then, effectively communicate their solutions to other people. As a result, the students who will use these instructional materials are asked to learn and use strategies for finding and presenting pertinent information and for thinking and problem-solving to complete the assignment and lab activity sheets that are the core of each unit of instruction in the series.

The success of this publication is due in large part to the capabilities of the personnel who worked with its development. Appreciation is extended to them for their valuable contributions to the publication.

These instructional materials are designed for student use and to assist instructors in organizing and improving instruction. These instructional materials are based on the curriculum-alignment concept of first stating the objectives (objective sheet), developing instructional strategies for teaching those objectives (information, assignment, and lab activity sheets), and assessing to those same objectives (written test—a criterion-referenced evaluation instrument).

Every effort has been made to make these instructional materials basic, readable, and by all means, usable. However, as with all of MAVCC's instructional materials, instructors must localize and personalize these materials to meet their community, classroom/laboratory, and individual student's situation. Instructors are encouraged to supplement the instructional materials and to develop strategies for motivating their students.

As you use these instructional materials, we hope that you will find that they contribute to the quality of your program. If any problems occur or if you have any suggestions for improving the materials, please call or write us.

Jean McEntire, Chair
Board of Directors
Multistate Academic and
Vocational Curriculum Consortium

Clark R. Harris
Executive Director
Multistate Academic and
Vocational Curriculum Consortium

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Appreciation is extended to those individuals who contributed their time and talent to the development of *Exploring Technology Education: Exploring Energy, Power, and Transportation Technology.*

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Technology Education Instructor
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Cleveland, Oklahoma

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Technology Education Instructor
Pawhuska High School
Pawhuska, Oklahoma

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Technology Education Instructor
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Hobart, Oklahoma

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Technology Education Instructor
Olustee Jr/Sr High School
Olustee, Oklahoma

Thanks are also extended to the following members of the Technology Education Division of the Oklahoma Department of Vocational and Technical Education for reviewing the rough drafts of the units of instruction as they were developed for this publication.

Lynn Hawkins
State Program Administrator

Donovan Bowers
Program Specialist

Harold Holley
Program Specialist

Thanks are extended, also, to Bob Davis, art department manager; Kim Hale, Kathryn Moore, and Suzi Currier, artists; Rose Primeaux, word processing supervisor; Karen Hart, word processing/desktop publishing operator; and the other employees of the Oklahoma Department of Vocational and Technical Education who assisted in the printing of these instructional materials.

Appreciation is also extended to the Agency for Instructional Technology (AIT) for providing the artwork used on the covers of the student and teacher editions of this publication.

Use of Introductory Materials

Introductory materials are included in the teacher edition only and contain useful information to assist administrators and teachers in planning for instruction.

In addition to the general information—such as the table of contents, foreword, and acknowledgments page—information is included on the following:

1. **Use of this publication**—Explains the components of a unit of instruction and how they should be used as part of the teaching/learning process.

2. **Competency profile**—Provides a record of student performance for each task included in a unit of instruction. This profile should become a part of the student's permanent course records.

3. **Instructional/task analysis**—Provides a quick review of the contents of the publication; identifies cognitive (knowledge) skills and psychomotor (doing) skills addressed in each unit of instruction.

4. **Academic and workplace skill classifications and definitions**—Defines the basic-skill classifications used by MAVCC. Skill areas reflected by skill groups, subskills, and definitions have been identified using *What Work Requires of Schools: A SCANS Report for America 2000* and *Workplace Basics: The Skills Employers Want.* These have been adapted by MAVCC.

5. **Related academic and workplace skills list**—Classifies unit tasks (assignment sheets and lab activity sheets) according to the related academic and workplace skills and competencies being reinforced.

As you use these materials, it is hoped that they will provide useful information to meet a variety of needs.

Use of This Publication

Instructional units

The instructional unit in the student edition of this publication includes the following components: objective sheet, information sheet, assignment sheets, lab activity sheets, and student supplements.

The teacher edition includes the following components: suggested activities, learning activities sheet, optional student supplements, optional assignment sheets, answers to assignment sheets, optional lab activity sheets, teacher supplements, written test, answers to written test, and unit evaluation form.

Units of instruction are designed for use in more than one lesson or class period of instruction, all of the unit components focus on measurable and observable learning outcomes, and careful study of the components in both the student and teacher edition for each unit of instruction by the teacher will help to determine the following:

- Amount of materials that can be covered in each class period.
- Skills that must be demonstrated.
- Amount of class time needed for teacher demonstrations.
- Amount of time needed for student practice.
- Supplementary materials, including print and nonprint media and equipment and supplies, that must be ordered.
- Resource people who must be contacted.

Student-edition components

It is a challenge to keep students motivated. Instructors should supplement the student-edition components by providing the "why," personal experiences, and current information. Prepare for each unit by deciding how each of the student components listed below can best be taught, and by allowing students to become involved in preparing and planning their teaching/learning experiences.

Objective sheet. Each unit of instruction is based on performance objectives that state the goals for successful completion of the unit. These performance objectives are presented in two forms on the objective sheet: (1) a unit objective, which states the expected performance of each student after completion of the unit of instruction, and (2) specific objectives, which state what the student must do to reach the unit objective.

The instructor should stress the unit objectives throughout the teaching/learning process. Doing so will help answer student questions concerning performance requirements for each instructional unit. The objectives can also help the instructor determine teaching strategies and instructional methods. Teachers should prepare for each unit by deciding how each objective can best be taught.

Teachers should feel free to modify, delete, or add objectives to an objective sheet in order to meet the needs of the students and community. When objectives are added, however, the teacher should remember also to add the needed information-sheet, assignment-sheet, lab-activity-sheet, and criterion-referenced written-test items.

Information sheet. The information sheet provides the students with the content essential for meeting the testable cognitive (knowledge) objectives of the unit; this means the cognitive information presented in the information sheet is tested in the criterion-referenced written test that is presented in the teacher edition for each unit of instruction.

Student supplements. The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students must be able to apply in order to complete one or more of the assignment sheets or lab activity sheets in a unit of instruction. Students are not directly tested over the cognitive information presented in a supplement; however, their ability to apply this information should be evaluated in scoring the completed assignment sheet/lab activity sheet associated with a supplement.

Assignment sheets. The assignment sheets presented in a unit of instruction provide students with pencil-and-paper activities that give students the opportunity to apply the testable cognitive objectives presented in the information sheet and the nontestable cognitive information presented in student supplements. Criteria are provided on each assignment sheet to assist the instructor in objectively evaluating student performance.

Lab activity sheets. The lab activity sheets presented in a unit of instruction provide students with psychomotor activities that give students the opportunity to apply the testable cognitive objectives presented in the information sheet and the nontestable cognitive information presented in the student supplements.

A worksheet is included in each lab activity sheet. The worksheet provides criteria to allow the instructor to objectively evaluate student performance of the particular psychomotor skills presented in a lab activity sheet and also requires the student to check with the instructor to discuss the methods, equipment, and materials the student is planning to use in completing the psychomotor activity in that lab activity sheet.

Teacher-edition components

Suggested activities. The suggested activities component assists teachers during the preparation stage of the teaching/learning process by providing an instructional plan and a list of suggested resources to be used with each unit of instruction.

The teacher should read the instructional-plan section of the suggested activities component before presenting the unit to his or her students and decide how each objective can best be presented, how to obtain supplemental materials required for the unit presentation, and which outside resources will be required for the unit presentation.

The teacher should read both subsections of the "suggested resources" section of the suggested activities to obtain ordering information for books and media to supplement the subject area covered in a unit of instruction.

The subsection called "resources used in developing this unit" lists the books and materials that were used by the writer in doing research for a particular unit of instruction. These materials can be used by the teacher to supplement her or his knowledge of the subject area presented in the unit of instruction or to provide background information to students with particular interests or objectives in the subject area covered in the unit of instruction.

The "suggested supplemental resources" subsection provides ordering information for printed material or media presentations that instructors may want to use to supplement the subject area of the objectives presented in the unit of instruction.

Learning activities sheet. The learning activities sheet supplied in each unit is a step-by-step instruction sheet instructors may copy and distribute to students to guide their individual study through the required components in the student edition (objective sheet, information sheet, student supplements, assignment sheets, and lab activity sheets).

Optional student supplements, optional assignment sheets, and optional lab activity sheets. When these components are provided in the teacher edition for a unit of instruction, they are optional cognitive-information sheets, pencil-and-paper activities, and psychomotor activities. These optional activities may be duplicated for student use. They allow the instructor to use his or her discretion in providing students with additional objectives in the same subject area as the required objectives provided in the student edition.

Assignment-sheet answers. Assignment-sheet answers are designed to assist the teacher in evaluating student performances on both the required assignment sheets in the student edition and the optional assignment sheets in the teacher edition.

Written test. This component is a criterion-referenced evaluation of every cognitive objective listed in the information sheet in the student edition. If the instructor has added, deleted, or modified objectives in the student edition, appropriate changes should be made on the written test. The test is included in the teacher edition only, but duplication is permitted for student use.

Written-test answers. This component is designed to assist the teacher in evaluating student performance on the written test.

Teacher supplements. Teacher supplements are optional materials for the teacher to use. They may provide the teacher with state-of-the-art information in which the teacher may not have background or with information that is not readily available in other books or with information they may need to help students complete the required assignments/lab activities in the student edition.

Unit evaluation form. This form provides teachers with a record of each student's performance on a unit of instruction. It includes space for assignment-sheet ratings, lab-activity-sheet ratings, written-test scores, and teacher comments. The unit evaluation form is included in the teacher edition only, but duplication is permitted for student use.

Competency Profile

Name: _____

Directions: Evaluate the student using one of the optional rating scales below. Write the appropriate numbers/letters to indicate the degree of competency achieved. The descriptions associated with each of the numbers/letters focus on a level of student performance for each of the tasks listed. The written-test scoreline is provided for optional teacher use. It may not be applicable in all cases.

Optional rating scales

Option A

Rating scale:
- 4 — **Skilled** – Can perform job with no additional training.
- 3 — **Moderately skilled** – Has performed job during training program; limited additional training may be required.
- 2 — **Limited skill** – Has performed job during training program; additional training is required to develop skill.
- 1 — **Unskilled** – Is familiar with process, but is unable to perform job.
- 0 — **No exposure** – No information or practice provided during training program; complete training is required.
- NA — **Non-applicable**.

Option B

Yes — Can perform job with no additional training.
No — Is unable to perform satisfactorily.

Exploring Energy, Power, and Transportation Technology

_____ 1. Research a career in energy, power, and transportation

_____ 2. Analyze a transportation system in your local area

_____ 3. Create and test a simple device for storing energy

_____ 4. Construct and evaluate the effectiveness of two simple solar collectors

_____ 5. Construct and analyze the operation of an energy-conversion simulator

_____ 6. Design, construct, and evaluate a water-powered lifting/lowering device

_____ 7. Design, construct, and evaluate a wind-powered delivery device

_____ 8. _____

_____Written-test score

Continue to back of this page.

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Competency Profile

Comments: _____

_____

_____

_____

_____

Evaluator: _____ Date: _____

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Permission to duplicate this profile is granted.

Instructional/Task Analysis

Exploring Energy, Power, and Transportation Technology

Related Information: What the student should know	Application: What the student should be able to do
1. Definitions of terms associated with energy and power	16. Research a career in energy, power, and transportation
2. Definitions of the stages in a basic technology systems model	17. Analyze a transportation system in your local area
3. Descriptions of the forms of energy	18. Create and test a simple device for storing energy
4. Types of exhaustible, inexhaustible, and renewable sources of energy	19. Construct and evaluate the effectiveness of two simple solar collectors
5. Goals of energy and power technology	20. Construct and analyze the operation of an energy-conversion simulator
6. Definitions of the classes of energy	21. Design, construct, and evaluate a water-powered lifting/lowering device
7. Characteristics of energy	22. Design, construct, and evaluate a wind-powered delivery device
8. Statements concerning the conversion of energy to power and the transmission of power to do work	
9. Definitions of the types of energy conversions	
10. Definitions of the types of motion	
11. Characteristics of motion	
12. Types of power systems used to control and transmit power	
13. Definition of the term *transportation*	
14. The goal of transportation technology	
15. Definitions of the types of transportation systems	

Academic and Workplace Skill Classifications and Definitions

Skill group	Subskill	Definition
Basic skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task.
	Writing	Communicating a thought, idea, or fact in written form in a clear, concise manner.
	Arithmetic/ mathematics	Performing basic computations, applying estimating and reasoning skills, and solving practical problems using a variety of mathematical techniques.
	Science	Applying knowledge learned through study and practice that is based on scientific principles, methods, and techniques.
	Listening	Receiving, interpreting, and responding to verbal messages and other cues.
	Speaking	Communicating a thought, idea, or fact verbally in a clear, concise manner.
Thinking skills	Creative thinking	Using imagination to generate new ideas.
	Decision making	Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative.
	Problem solving	Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results.
	Seeing things in the mind's eye	Mentally organizing and processing symbols, pictures, graphs, and other information.
	Knowing how to learn	Using efficient learning techniques to acquire and apply new knowledge and skills.
	Reasoning	Applying a rule or principle underlying the relationship between two or more objects when solving a problem.
Personal-management skills	Responsibility	Exerting a high level of effort towards goal attainment, working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration.
	Self-esteem	Developing self-confidence and maintaining a positive view of self.
	Career awareness, development, and mobility	Assessing self accurately, setting personal goals, establishing and implementing a plan, and monitoring progress.
	Integrity/honesty	Choosing an ethical course of action when faced with making a decision that may break with personal or societal values and recognizing the impact of violating these beliefs and codes on an organization, self, and others.
	Organizational effectiveness	Adapting to the organization's goals, values, culture, and traditional modes of operation.

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Academic and Workplace Skill Classifications and Definitions

Skill group	Subskill	Definition
Resources	Time	Selecting relevant, goal-related activities; ranking them in order of importance; allocating time; and understanding, preparing, and following schedules.
	Money	Using or preparing budgets, making forecasts, keeping records, and making adjustments to meet objectives.
	Material and facilities	Acquiring, storing, and using materials and space efficiently.
	Human resources	Assessing skills and distributing work accordingly; evaluating performance and providing feedback.
Interpersonal skills	Teamwork	Working cooperatively with others to reach a common goal.
	Coaching	Helping others learn new skills.
	Leadership	Communicating ideas to justify position; accepting responsibility for others; and encouraging, persuading, convincing, or otherwise motivating an individual or group.
	Negotiation	Resolving conflict between two or more individuals through discussion and compromise.
	Customer service	Working and communicating with customers to satisfy their expectations.
	Cultural diversity	Working well with men and women with a variety of ethnic, social, or educational backgrounds.
Information	Acquisition and evaluation	Identifying need for data, obtaining it from existing sources or creating it, and evaluating its relevance and accuracy.
	Organization and storage	Organizing, processing, and maintaining written or computerized records and other forms of information in a systematic way.
	Interpretation	Selecting and analyzing information and communicating the results to others.
	Processing	Using computers to acquire, organize, analyze, and communicate information.
Systems	Interrelationships	Knowing how social, organizational, and technological systems work and operate effectively.
	Monitoring	Distinguishing trends, predicting impact of actions on system operations, diagnosing deviations in systems' performance, and correcting malfunctions.
	Modification and design	Making suggestions to modify existing systems to improve products or services, and developing new or alternative systems.
Technology	Selection	Choosing procedures, tools, or equipment including computers and related technologies.
	Application	Demonstrating proper procedures for setting up and operating equipment.
	Maintenance and troubleshooting	Preventing, identifying, or solving problems with equipment, including computers and other technologies.

Related Academic and Workplace Skills List

Exploring Energy, Power, and Transportation Technology

Task	Skill group	Subskill	Definition
Research a career in energy, power, and transportation (A.S. 1)	Basic skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task
		Writing	Communicating a thought, idea, or fact in written form in a clear, concise manner
	Thinking skills	Knowing how to learn	Using efficient learning techniques to acquire and apply new knowledge and skills
	Personal-management skills	Career awareness, development, and mobility	Assessing self accurately, setting personal goals, establishing and implementing a plan, and monitoring progress
	Information	Acquisition and evaluation	Identifying need for data, obtaining it from existing sources or creating it, and evaluating its relevance and accuracy
		Interpretation	Selecting and analyzing information and communicating the results to others
Analyze a transportation system in your local area (A.S. 2)	Basic skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task
		Writing	Communicating a thought, idea, or fact in written form in a clear, concise manner
	Thinking skills	Creative thinking	Using imagination to generate new ideas
		Seeing things in the mind's eye	Mentally organizing and processing symbols, pictures, graphs, and other information
		Reasoning	Applying a rule or principle underlying the relationship between two or more objects when solving a problem
	Information	Acquisition and evaluation	Identifying need for data, obtaining it from existing sources or creating it, and evaluating its relevance and accuracy
		Interpretation	Selecting and analyzing information and communicating the results to others
	Systems	Interrelationships	Knowing how technological systems work and operate effectively
Create and test a simple device for storing energy (L.A.S. 1)	Basic skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task
		Writing	Communicating a thought, idea, or fact in written form in a clear, concise manner
		Science	Applying knowledge learned through study and practice that is based on scientific principles, methods, and techniques

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Task	Skill group	Subskill	Definition
L. A. S. 1 (cont.)	Resources	Material and facilities	Acquiring, storing, and using materials and space efficiently
	Information	Interpretation	Selecting and analyzing information and communicating the results to others
	Technology	Selection	Choosing procedures, tools, or equipment including computers and related technologies
		Application	Demonstrating proper procedures for setting up and operating equipment
Construct and evaluate the effectiveness of two simple solar collectors (L.A.S. 2)	Basic skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task
		Writing	Communicating a thought, idea, or fact in written form in a clear, concise manner
		Science	Applying knowledge learned through study and practice that is based on scientific principles, methods, and techniques
	Thinking skills	Decision making	Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative
		Problem solving	Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results
		Seeing things in the mind's eye	Mentally organizing and processing symbols, pictures, graphs, and other information
	Resources	Material and facilities	Acquiring, storing, and using materials and space efficiently
	Information	Interpretation	Selecting and analyzing information and communicating the results to others
	Technology	Selection	Choosing procedures, tools, or equipment including computers and related technologies
		Application	Demonstrating proper procedures for setting up and operating equipment
Construct and analyze the operation of an energy-conversion simulator (L.A.S. 3)	Basic skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task
		Writing	Communicating a thought, idea, or fact in written form in a clear, concise manner
		Science	Applying knowledge learned through study and practice that is based on scientific principles, methods, and techniques
	Thinking skills	Problem solving	Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results

Task	Skill group	Subskill	Definition
L. A. S. 3 (cont.)		Reasoning	Applying a rule or principle underlying the relationship between two or more objects when solving a problem
	Resources	Material and facilities	Acquiring, storing, and using materials and space efficiently
	Information	Interpretation	Selecting and analyzing information and communicating the results to others
	Technology	Selection	Choosing procedures, tools, or equipment including computers and related technologies
		Application	Demonstrating proper procedures for setting up and operating equipment
Design, construct, and evaluate a water-powered lifting/lowering device (L.A.S. 4)	Basic skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task
		Writing	Communicating a thought, idea, or fact in written form in a clear, concise manner
		Science	Applying knowledge learned through study and practice that is based on scientific principles, methods, and techniques
	Thinking skills	Creative thinking	Using imagination to generate new ideas
		Decision making	Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative
		Problem solving	Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results
		Seeing things in the mind's eye	Mentally organizing and processing symbols, pictures, graphs, and other information
		Reasoning	Applying a rule or principle underlying the relationship between two or more objects when solving a problem
	Resources	Material and facilities	Acquiring, storing, and using materials and space efficiently
	Interpersonal skills	Teamwork	Working cooperatively with others to reach a common goal
	Information	Acquisition and evaluation	Identifying need for data, obtaining it from existing sources or creating it, and evaluating its relevance and accuracy
		Organization and storage	Organizing, processing, and maintaining written or computerized records and other forms of information in a systematic way
		Interpretation	Selecting and analyzing information and communicating the results to others

Related Academic and Workplace Skills List

Task	Skill group	Subskill	Definition
L. A. S. 4 (cont.)	Systems	Interrelationships	Knowing how technological systems work and operate effectively
		Monitoring	Distinguishing trends, predicting impact of actions on system operations, diagnosing deviations in systems' performance, and correcting malfunctions
		Modification and design	Making suggestions to modify existing systems to improve products or services, and developing new or alternative systems
	Technology	Selection	Choosing procedures, tools, or equipment including computers and related technologies
		Application	Demonstrating proper procedures for setting up and operating equipment
		Maintenance and troubleshooting	Preventing, identifying, or solving problems with equipment, including computers and other technologies
Design, construct, and evaluate a wind-powered delivery device (L.A.S. 5)	Basic skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task
		Writing	Communicating a thought, idea, or fact in written form in a clear, concise manner
		Science	Applying knowledge learned through study and practice that is based on scientific principles, methods, and techniques
	Thinking skills	Creative thinking	Using imagination to generate new ideas
		Decision making	Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative
		Problem solving	Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results
		Seeing things in the mind's eye	Mentally organizing and processing symbols, pictures, graphs, and other information
		Reasoning	Applying a rule or principle underlying the relationship between two or more objects when solving a problem
	Resources	Material and facilities	Acquiring, storing, and using materials and space efficiently
	Interpersonal skills	Teamwork	Working cooperatively with others to reach a common goal
	Information	Acquisition and evaluation	Identifying need for data, obtaining it from existing sources or creating it, and evaluating its relevance and accuracy

Related Academic and Workplace Skills List

Task	Skill group	Subskill	Definition
L. A. S. 5 (cont.)		Organization and storage	Organizing, processing, and maintaining written or computerized records and other forms of information in a systematic way
		Interpretation	Selecting and analyzing information and communicating the results to others
	Systems	Interrelationships	Knowing how technological systems work and operate effectively
		Monitoring	Distinguishing trends, predicting impact of actions on system operations, diagnosing deviations in systems' performance, and correcting malfunctions
		Modification and design	Making suggestions to modify existing systems to improve products or services, and developing new or alternative systems
	Technology	Selection	Choosing procedures, tools, or equipment including computers and related technologies
		Application	Demonstrating proper procedures for setting up and operating equipment
		Maintenance and troubleshooting	Preventing, identifying, or solving problems with equipment, including computers and other technologies
		Decision making	Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative

Suggested Activities

Instructional plan

Preparation

Plan your presentation.

- Review the student components presented for this unit in the student edition.
  - — Objective Sheet
  - — Information Sheet
  - — Assignment Sheet 1, "Research a Career in Energy, Power, and Transportation"
  - — Assignment Sheet 2, "Analyze a Transportation System in Your Local Area"
  - — Student Supplement 1, "Components of Transportation Systems"
  - — Lab Activity Sheet 1, "Create and Test a Simple Device for Storing Energy"
  - — Lab Activity Sheet 2, "Construct and Evaluate the Effectiveness of Two Simple Solar Collectors"
  - — Lab Activity Sheet 3, "Construct and Analyze the Operation of an Energy-Conversion Simulator"
  - — Lab Activity Sheet 4, "Design, Construct, and Evaluate a Water-Powered Lifting/Lowering Device"
  - — Student Supplement 2, "Devices Used for Controlling and Transmitting Power in Mechanical Power Systems"
  - — Lab Activity Sheet 5, "Design, Construct, and Evaluate a Wind-Powered Delivery Device"
- Review the teacher components presented for this unit in this teacher edition.
  - — Learning Activities Sheet
  - — Teacher Supplement 1, "Using the AIT Media Programs"
  - — Optional Assignment Sheet 1, "AIT Media Questions for Discussion and Review"
  - — Teacher Supplement 2, "Construction Sketches for Equipment Required in Lab Activity Sheet 3"
  - — Optional Assignment Sheet 2, "Perform an Energy Audit"
  - — Optional Student Supplement 1, "Insulation Information"
  - — Optional Student Supplement 2, "Energy-Audit Record Form"
  - — Optional Assignment Sheet 3, "Solve Problems Involving Energy and Power Measurement"
  - — Answers to Assignment Sheets
  - — Optional Lab Activity Sheet 1, "Construct a Pneumatic Third-Class Lever"
  - — Written Test
  - — Answers to Written Test
  - — Unit Evaluation Form

Suggested Activities

The **Learning Activities Sheet** is a step-by-step instruction sheet you may copy and distribute to your students to guide their individual study through the required components in the student edition (Objective Sheet, Information Sheet, Assignment Sheets, Student Supplements, Lab Activity Sheets).

Note that Step 3 on the Learning Activities Sheet asks the student to watch unnamed media presentations and complete the questions for discussion and review.

You may obtain and show the AIT media presentations designed to go with this unit. **Teacher Supplement 1, "Using the AIT Media Programs,"** summarizes the content of these presentations (see the Suggested Supplemental Materials section below for ordering information.)

If you select the AIT media presentations, you may use **Optional Assignment Sheet 1**, in Step 3, which asks students to complete questions for discussion and review. If you use other media presentations, you should prepare your own questionnaire to be used with Step 3 on the Learning Activities Sheet and title it "Questions for Discussion and Review."

Teacher Supplement 2, "Construction Sketches for Equipment Required in Lab Activity Sheet 3," provides you with a diagram for making the turbine component and motor base that your students will use in completing Lab Activity Sheet 3, "Construct and Analyze the Operation of an Energy-Conversion Simulator," in the student edition.

Optional Assignment Sheet 2, "Perform an Energy Audit," Optional Student Supplement 1, "Insulation Information," and **Optional Student Supplement 2, "Energy-Audit Record Form,"** compose one optional pencil-and-paper assignment you may select to use with the required assignment sheets in the student edition while studying energy, power, and transportation.

Optional Assignment Sheet 3, "Solve Problems Involving Energy and Power Measurement," is another pencil-and-paper assignment you may select to use along with the required assignment sheets in the student edition.

Optional Lab Activity Sheet 1, "Construct a Pneumatic Third-Class Lever," is an optional psychomotor activity you may select to use along with the required lab activity sheets in the student edition.

- Modify the Learning Activities Sheet as needed to reflect your instructional plan. Copy and prepare the Learning Activities Sheet for distribution to your students.
- Copy and prepare the teacher components you select to distribute to your students (Written Test, Unit Evaluation Form).
- Prepare the classroom by putting up posters and charts and displaying articles and other references related to the objectives of this unit.

Suggested Activities

Delivery and application

Have students complete the steps in the Learning Activities Sheet, "Exploring Energy, Power, and Transportation Technology."

Evaluation

- Evaluate the assignment sheets. See the evaluation criteria listed at the top of each assignment sheet as well as the teacher page **Answers to Assignment Sheets**.
- Evaluate the lab activity sheets. See the evaluation criteria listed on the worksheet that accompanies each lab activity sheet.
- Give the written test. See the teacher page **Written Test**.
- Evaluate the written test. See the teacher page **Answers to Written Test**.
- Compile written-test, assignment-sheet, and lab-activity-sheet scores. See the teacher page **Unit Evaluation Form**.
- Reteach and retest as required.

Suggested resources

Resources used in developing this unit

Print media

- Bowers, Donovan, and Mary Kellum. *Exploring Energy, Power, and Transportation Technology*. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc., 1987.
- Murray, Steve. *Exploring Technology Education*, 2nd ed. Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc., 1991.

Suggested supplemental resources

Nonprint media

- AIT media programs, copyright 1990:

  Introduction to Energy

  Energy Conversion and Measurement

  Power Transmission, Control, and Storage

  Transportation Systems

  Available from:

  Agency for Instructional Technology (AIT)
  Box A
  Bloomington, Indiana 47402

  Phone: (800) 457-4509 or (812) 339-2203

Exploring Energy, Power, and Transportation Technology

Learning Activities Sheet

Put a checkmark in each blank as you complete each of the steps below.

_____ 1. **Read** Objective Sheet.

_____ 2. **Study** Information Sheet.

_____ 3. **Watch** Media presentations _____

_____

_____

and

Complete "Questions for Discussion and Review."

_____ 4. **Do** Assignment Sheet 1, "Research a Career in Energy, Power, and Transportation."

_____ 5. **Stop** Have your instructor evaluate the completed assignment sheet. If the evaluation is satisfactory, continue to Step 6. If the evaluation is not satisfactory, repeat Step 4.

_____ 6. **Do** Lab Activity Sheet 1, "Create and Test a Simple Device for Storing Energy."

_____ 7. **Stop** Have your instructor evaluate the completed lab activity. If the evaluation is satisfactory, continue to Step 8. If the evaluation is not satisfactory, repeat Step 6.

_____ 8. **Do** Lab Activity Sheet 2, "Construct and Evaluate the Effectiveness of Two Simple Solar Collectors."

_____ 9. **Stop** Have your instructor evaluate the completed lab activity. If the evaluation is satisfactory, continue to Step 10. If the evaluation is not satisfactory, repeat Step 8.

_____ 10. **Do** Lab Activity Sheet 3, "Construct and Analyze the Operation of an Energy-Conversion Simulator."

_____ 11. **Stop** Have your instructor evaluate the completed lab activity. If the evaluation is satisfactory, continue to Step 12. If the evaluation is not satisfactory, repeat Step 10.

_____ 12. **Read** Student Supplement 2, "Devices Used for Controlling and Transmitting Power in Mechanical Power Systems."

Continue to the next page.

_____ 13.	**Do**	Lab Activity Sheet 4, "Design, Construct, and Evaluate a Water-Powered Lifting/Lowering Device."
_____ 14.	**Stop**	Have your instructor evaluate the completed lab activity. If the evaluation is satisfactory, continue to Step 15. If the evaluation is not satisfactory, repeat Steps 12 and 13.
_____ 15.	**Do**	Lab Activity Sheet 5, "Design, Construct, and Evaluate a Wind-Powered Delivery Device."
_____ 16.	**Stop**	Have your instructor evaluate the completed lab activity. If the evaluation is satisfactory, continue to Step 17. If the evaluation is not satisfactory, repeat Step 15.
_____ 17.	**Read**	Student Supplement 1, "Components of Transportation Systems."
_____ 18.	**Do**	Assignment Sheet 2, "Analyze a Transportation System in Your Local Area."
_____ 19.	**Stop**	Have your instructor evaluate the completed assignment sheet. If the evaluation is satisfactory, continue to Step 20. If the evaluation is not satisfactory, repeat Steps 17 and 18.
_____ 20.	**Stop**	Check with your instructor for any optional activities he or she may choose to assign.
_____ 21.	**Do**	Optional activities listed below.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Continue to the next page.

_____ 22.	**Stop**	Have your instructor evaluate the optional activities. If the evaluation is satisfactory, continue to Step 23. If the evaluation is not satisfactory, repeat Step 21 as your instructor directs.
_____ 23.	**Take**	Written Test.
_____ 24.	**Stop**	Have your instructor evaluate the completed written test. If the evaluation is satisfactory, proceed to the next learning activities sheet. If your evaluation is not satisfactory, ask your instructor for directions for reviewing the information in this unit.

Permission to duplicate this form is granted.

Teacher Supplement 1—Using the AIT Media Programs

Note

A series of four AIT media programs was designed to supplement this unit, "Exploring Energy, Power, and Transportation Technology": (1) "Introduction to Energy"; (2) "Energy Conversion and Measurement"; (3) "Power Transmission, Control, and Storage"; and (4) "Transportation Systems." Summaries and objectives for each of these four programs are given below.

Program name

AIT media, "Introduction to Energy"

Program summary

This program introduces energy—its definition, sources, forms, technological advances, uses, and impact upon society and the environment. It examines the various sources of energy and describes their relative "life" expectancies, benefits, and contemporary problems.

Defining *energy* as "the ability to do work," the program opens with a brief historical survey showing that an early source of energy was human muscle power, and that the development of the highly technological society of today has depended on ample sources of energy. Sources of energy are defined as *exhaustible, renewable,* or *inexhaustible.*

Some exhaustible energy sources derive from fossil fuels. Coal powers more than half the electrical plants in the United States. Its conversion to electricity can be described by the system model. Oil powers most transportation, and natural gas and nuclear fission are also important sources of energy. Fossil fuels pollute, however, and produce acid rain, which Edwardo Rhodes, an environmental scientist, discusses.

Renewable energy sources include wood and methanol, which is produced by the bioconversion of wood, grain, or even waste into alcohol. These sources are very inefficient, however.

Inexhaustible sources of energy include wind, hydroelectric, tidal, and geothermal power, and the sun, which produces solar energy through nuclear fusion. Until we develop the technology to harness the inexhaustible sources effectively, we need to work toward energy conservation and efficiency.

Program objectives

The media program is designed to illustrate that

- there are many sources of energy, both traditional and alternative.
- our use of energy sources affects society and the environment.

Teacher Supplement 1

Program name

AIT media, "Energy Conversion and Measurement"

Program summary

This program presents different forms of energy, the conversion of one form into another, and all forms as sources of power. It also introduces six ways of measuring these forms of energy. The program focuses on the use of these forms of energy today and the requirements for energy for the future.

Defining *power* as "the rate of doing work," the program opens with scenes of a solar-powered car racing across Australia. The narrator explains that energy is useful only when it is converted into power. Examples are shown of the six forms of energy: heat, chemical, mechanical, light, electrical, and nuclear. Potential (or stored) energy is converted into kinetic (or mechanical) energy; humans store chemical energy and release it in mechanical form, while coal stores the radiant energy of the sun. A tour of a coal-fired electrical plant shows how the production of electricity can be described in terms of the systems model.

Conversion of energy involves some loss, often as thermal energy. Energy used or lost can be measured as force, work, torque, pressure, BTUs, or horsepower. The narrator returns to the example of the General Motors Sunraycer and describes its great energy efficiency. An interview with its designer, Paul MacCready, is the occasion for presenting his earlier designs, including human- and solar-powered aircraft. The systems model describes the conversion of solar energy into mechanical power.

The future will require great energy efficiency. Seawater is a possible source of power. Nuclear fission will not be fully effective as a source of power until we can solve the problem of nuclear wastes.

Program objectives

The media program is designed to illustrate that

- energy comes in different forms.
- energy is useful only when it is converted into power.
- because energy is lost when it is converted, we need to be able to measure and monitor it.

Program name

AIT media, "Power Transmission, Control, and Storage"

Program summary

This program presents the need for controlling power, systems for transmitting it, and ways of storing it.

Opening with a scene of a hovercraft-like vehicle built by technology students, the program emphasizes that to use power, we must control it. Controlling power often means stopping, starting, or changing the direction of a force. Control of power is needed in all four technical areas—communication, construction, manufacturing, and transportation. To control power, however, we need to be able to transmit it.

The program introduces and demonstrates four transmission systems: mechanical, fluid, electrical, and thermal. An engineer explains how his model blimp uses various complex systems to control and transmit power. An automobile mechanic explains how the failure of a car to start can involve any of the four systems for transmitting power.

Often power must be stored. The program shows examples of electrical, fluid, thermal, and mechanical storage systems. It then returns to the hovercraft vehicle, which the students are testing. Their control system is not perfect, and they have difficulty steering it. In the future, superconductivity and lasers may help us find new ways to control and transmit power.

Program objectives

The media program is designed to illustrate that

- power must often be transmitted to do useful work.
- to be used effectively, power must be controlled.
- power can be stored for later use.

Program name

AIT media, "Transportation Systems"

Program summary

This program presents different kinds of transportation systems and discusses the history and growth of transportation technology.

Defining *transportation* as "the movement of people and things," the program points out that transportation systems can be analyzed in terms of the systems model. Transportation systems use land, water, air, and space.

The program reviews technological progress in transportation through history. The earliest systems used human and animal power; the railroad brought mass transportation; and cars made travel private and personal. Today, automotive manufacturing is the largest industry in the world, and Japan's bullet train travels at up to 200 miles per hour. On water, transportation has progressed from primitive canoes to today's large cargo ships. Air travel began with balloons and attempts to build human-powered aircraft. The Wright brothers' successful flying machine led to the "shrinking of the world" and to the exploration of space.

The program visits the headquarters of Federal Express and profiles a courier. Such large intermodal transportation networks involve a variety of transportation systems working together. The transportation of the future will undoubtedly bring greater distance and speed with less expenditure of energy. Electric or solar cars, trains moving by magnetic levitation, a space plane, and an orbiting space station are all possibilities that are becoming realities. In the meantime, we have to confront the problem of our decaying infrastructure, roads, and bridges.

Program objectives

The media program is designed to illustrate that

- transportation is used to conquer time and space.
- efficient transportation systems are often intermodal, involving several different kinds of transportation.
- transportation technologies continue to advance while the infrastructure of roads, bridges, highways, airports, and railways is deteriorating.

Exploring Energy, Power, and Transportation Technology

Optional Assignment Sheet 1—AIT Media Questions for Discussion and Review

Name _____ Date _____

Evaluation criteria	Rating
Directions have been followed.	_____
Student responses are relevant and well thought out.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____

Exercise

Directions As you watch each of the following AIT media presentations, answer the following questions in the space provided below each question.

Part A **AIT media, "Introduction to Energy"**

Discussion/ review questions

1. What is *energy*?

2. What are the three supply categories in which energy sources are grouped, and what are two examples of each group shown in the media program?

3. What are three examples of fossil fuels? What are the principal uses of each type?

Optional Assignment Sheet 1

4. What category of energy source (exhaustible, renewable, inexhaustible) currently meets 90 percent of our energy needs? Why is it important that we use renewable or inexhaustible energy sources instead of exhaustible sources?

5. What is *bioconversion*? Why is it inefficient?

6. How has our use of energy sources affected society and the environment?

7. What can be done to conserve energy in transportation? in designing, building, and living in homes?

8. What does the media program mention as examples of abundant sources of clean energy?

Optional Assignment Sheet 1

Part B **AIT media, "Energy Conversion and Measurement"**

Discussion/ review questions

1. Why do we convert energy into power?

2. What are the six forms of energy discussed in the media program? Which form of energy is the most portable and most closely associated with stored energy?

3. Energy is converted from one form to another to meet a specific need. Give an example of the following conversions:

   a. light to electrical

   b. chemical to electrical

   c. chemical to thermal

   d. electrical to mechanical

4. a. Describe the conversions that take place to produce electrical energy to light the laboratory.

   b. Use the systems model to describe the energy conversions when a person runs.

5. What is the difference between *potential energy* and *kinetic energy*? Give an example of each.

6. What is an example of *wasted energy*?

7. Why is it important to measure energy accurately? List the different measurement terms discussed in the media program and describe what they measure.

Part C **AIT media, "Power Transmission, Control, and Storage"**

Discussion/ review questions

1. Control devices are used in power systems to change movement to a more usable form. What are the most common changes?

2. What are given in the media program as examples of the need to control energy and power in manufacturing? In construction? In communication? In transportation?

3. What are the four power systems for controlling and transmitting power that were discussed in the media program?

4. What are examples of power being controlled or transmitted in the four systems?

5. What systems were demonstrated with the model blimp?

6. What was the purpose of controlling power for launching and landing aircraft on the aircraft carrier? How did they do it?

7. What energy storage devices are associated with the different power systems?

Part D **AIT media, "Transportation Systems"**

Discussion/ review questions

1. What is *transportation*?

Optional Assignment Sheet 1

2. What are some examples of transportation and the problems it addresses?

3. Where does transportation occur?

4. Historically, what are some of the major technological developments in transportation that are described in the media program?

5. Describe Federal Express's subsystems of intermodal transportation. What is the advantage of intermodal transportation?

6. What will transportation be like in the future?

7. What are current problems in transportation?

8. What is the safest form of public transportation?

Teacher Supplement 2—Construction Sketches for Equipment Required in Lab Activity Sheet 3

Introduction

In the student edition in Lab Activity Sheet 3, "Construct and Analyze the Operation of an Energy-Conversion Simulator," students will assemble a conversion-simulator setup as shown in Figure 1 below.

You will be asked to supply them with the electric motor mounted on a wood-block base and the turbine component that is attached to the electric motor (see Figure 1).

Use the sketches in Figure 2 on the next page for a pattern for shaping the turbine component and for the wood-block base upon which the electric motor is mounted.

Figure 1: Conversion-simulator setup

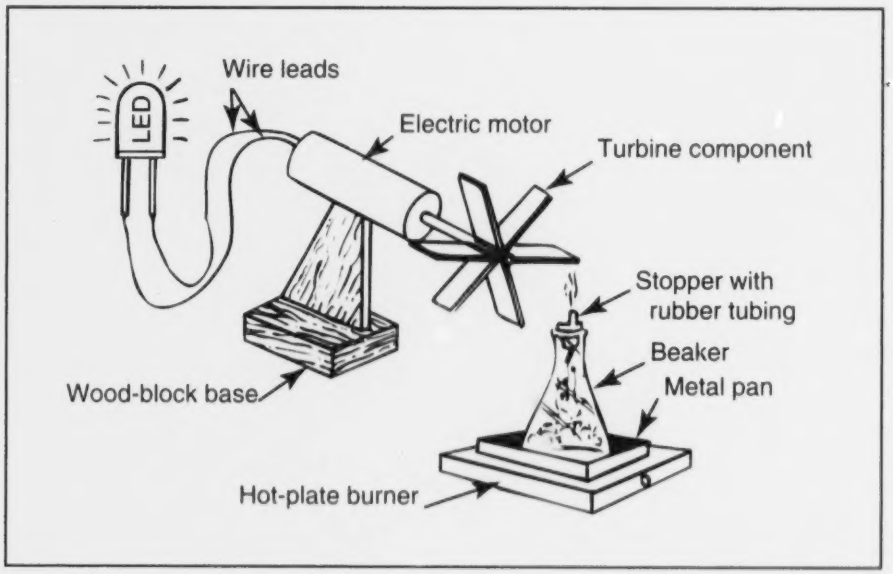
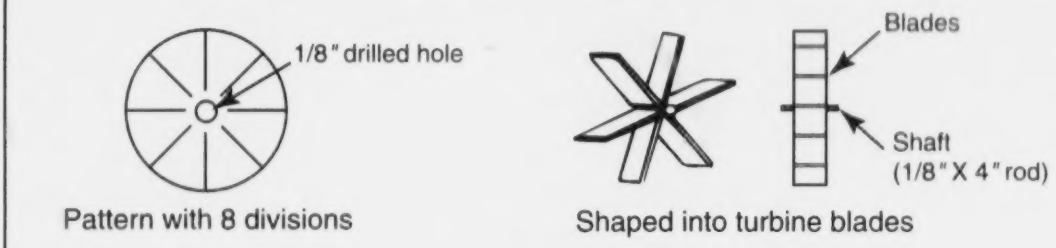


Figure 2: Turbine-component and motor-base construction sketches



a. **Turbine component**

Beginning with two ½" thick x 6" square wood blocks, prepare the wood blocks as shown and attach with hot glue.

b. **Motor base**

Optional Assignment Sheet 2—Perform an Energy Audit

Name _____ Date _____

Evaluation criteria	Rating
Directions have been followed.	_____
Information provided on energy-audit record form is complete and accurate.	_____
Recommendations in comments sections are complete and appropriate.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____

Introduction

When learning about energy, power, and transportation technology, you need to understand the drawbacks of using this technology as well as the benefits. One of the drawbacks of using this technology is that the most commonly used sources of energy are exhaustible. And, until the technology systems are able to find ways of efficiently and effectively converting to inexhaustible and renewable forms of energy, the exhaustible sources must be conserved. By doing so, we can save money, reduce the environmental impact of the use of exhaustible sources of energy by reducing their harmful emissions, decrease the amount of energy that must be produced to meet energy demands, and lessen our reliance on foreign energy sources.

Transportation systems will have to use more efficient engines and lightweight materials for vehicle designs. The manufacturing and construction industries will have to create designs that use the heat that is lost as waste in furnaces, machinery, and processes; recycle raw materials; and develop more energy-efficient tools and appliances. Communication, too, will have to develop more energy-efficient new technologies as well as more energy-efficient methods for existing technologies.

Energy conservation, however, begins at home. We can insist on buying only more energy-efficient new homes, and we can modify existing structures to make them more energy efficient. We can:

- insulate and weather-strip,
- turn off lights when they are not needed,

Optional Assignment Sheet 2

- lower the thermostat setting in winter and raise it in summer,
- buy only energy-efficient appliances,
- conserve hot water,
- recycle household products, and
- compost yard waste.

To complete this assignment sheet, you will perform an energy audit of your home. By doing so, you will learn more about effective ways you can conserve energy.

Exercise

Activity checklist

Put a checkmark on the blank before each activity below as you complete it.

_____ 1. Read Optional Student Supplement 1, "Insulation Information," which begins on page 23.

_____ 2. Review the questions/items in Optional Student Supplement 2, "Energy-Audit Record Form," which begins on page 25.

_____ 3. Obtain the following supplies from your instructor:

- thermometer (that will read to at least 180 degrees F)
- immersion thermometer
- 1/2-inch dowel rod
- 6 x 6-inch square of light tissue paper or plastic wrap
- masking tape

_____ 4. Make a draft indicator: attach the tissue-paper/plastic-wrap square to the dowel rod with the masking tape.

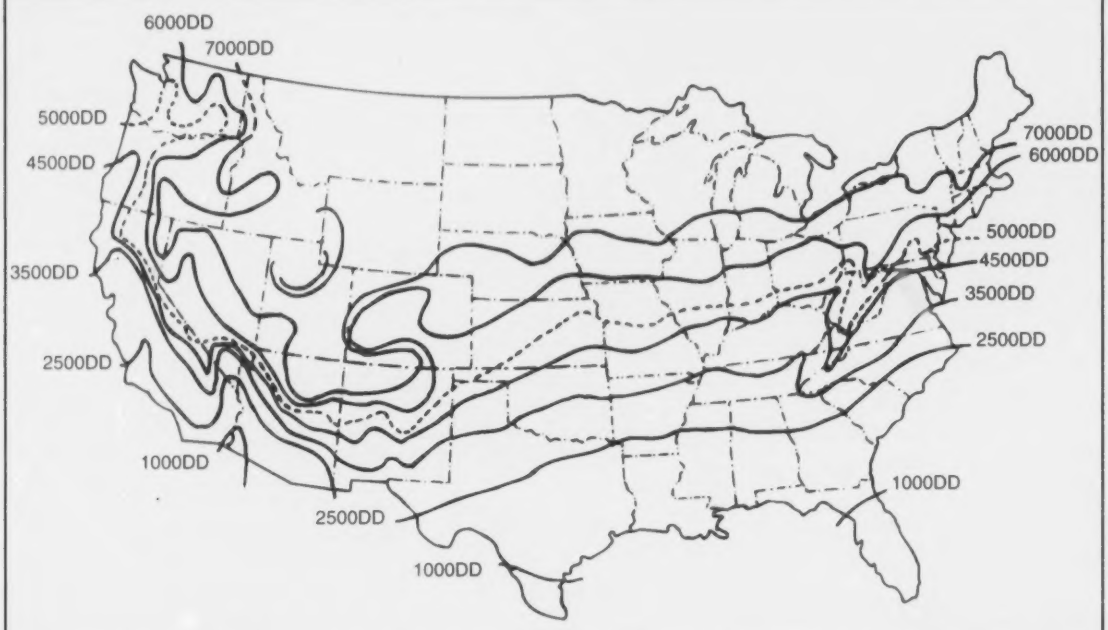
_____ 5. Inspect your home and complete the energy-audit record form in Optional Student Supplement 2.

_____ 6. Turn in your completed energy-audit record form to your instructor for evaluation.

_____ 7. Your instructor will return your record form with suggestions for improvement. Make the improvements your instructor suggests, and then, return your record form to your instructor for final evaluation.

Optional Student Supplement 1—Insulation Information

Figure 1: U.S. map showing normal number and degree-days per year



This map is reasonably accurate for most parts of the United States but is necessarily highly generalized, and consequently, not too accurate in mountainous regions, particularly in the Rockies.

Figure 2: Recommended insulation R-values

Degree days	Ceilings	Walls	Floors
Above 7000	38	17	19
6001-7000	38 (30F)	17 (12F)	19 (11F)
4501-6000	30	17 (12F)	19 (11F)
3501-4500	30	12 (17E)	11 (19E)
2501-3000	22 (30E)	11 (17E)	0 (11E)
1001-2500	19 (22E)	11 (12E)	0
1000 and under	19	11	0

Fossil fuel (gas and oil) = F
Electric resistance heat = E
Heat pumps with electric heat = H
R-values apply to all unless otherwise shown.

These insulation R-values are recommended to meet the FHA Minimum Property Standards for thermal resistanoe. The R-value shown for walls can be met with any combination of sheathing and cavity-wall insulation, or blanket insulation alone. For additional information, refer to Owens-Corning Pub. No. 5-BL-9293-A.

BEST COPY AVAILABLE

Figure 3: Resistance of various insulating materials

Material type	R-value per inch	Inches needed for value indicated				
		R-11	R-19	R-22	R-34	R-38
Batt/blanket						
Fiberglass	3.14	3.5	6	7	11	12.5
Rock wool	3.14	3.5	6	7	11	12.5
Loose/machine-blown						
Glass fiber	2.25	5	8.5	10	15.5	17
Rock wool	3.125	3.5	6	7	11	12.5
Cellulose	3.75	3	5.5	6	9.5	10.5
Hand-poured/loose-fill						
Cellulose	3.7	3	5.5	6	9.5	10.5
Rock wool	3.125	3.5	6	7	11	12.5
Glass fiber	2.25	5	8.5	10	15.5	17
Vermiculite	2.1	5.5	9	10.5	16.5	18
Rigid-board						
Polystyrene beadboard	3.6	3	5.5	6.5	9.5	10.5
Extruded polystyrene	5.41	3	5	5.5	8.5	9.5
Urethane	6.2	2	3	3.5	5.5	6.5
Glass fiber	4	3	5	5.5	8.5	9.5

Optional Student Supplement 2—Energy-Audit Record Form

Introduction Use the energy-audit record form below in completing Optional Assignment Sheet 2, "Perform an Energy Audit."

Directions Inspect the various areas of your home that are indicated on the record form below. Completely fill out the required items/questions and the comments section on each part as you proceed through your inspection.

Energy-Audit Record Form

Part A: Exterior doors

1. How many exterior doors are there in your home? (Record the number on the blank line provided below.)

   Number of exterior doors _____

2. Does each door have a storm door? Yes No
3. Is each door properly weatherstripped? Yes No
4. Is each door frame properly caulked? Yes No
5. If any door contains glass, how many panes of glass are in the glass area of the door? (Put a checkmark in the appropriate square[s] below.)

   ☐ Single-pane ☐ Double-pane ☐ Triple-pane

Comments concerning needed replacements/repairs _____

_____

_____

_____

Part B: Windows

Exterior inspection

1. How many windows are located on each exterior wall? (Record the number on the appropriate blank line provided below.)

   North wall _____ South wall _____

   East wall _____ West wall _____

Part B: **Windows** (cont.)

2. What kind of frames are on the windows? (Put a checkmark in the appropriate square[s] below.)

   ☐ Wood ☐ Metal

3. Are storm windows used over windows during the winter months? Yes No

4. Does each window close tightly? Yes No

5. Is each window frame properly caulked? Yes No

6. Are any windows broken? Yes No

7. How many panes of glass are in the glass area of the windows? (Put a checkmark in the appropriate square[s] below.)

   ☐ Single-pane ☐ Double-pane ☐ Triple-pane

Interior inspection

8. How are the windows covered to control light and prevent heat loss/gain? (Put a checkmark in the appropriate square[s] below.)

   ☐ Blinds ☐ Shutters ☐ Shades

   ☐ Curtains ☐ Drapes ☐ Reflective coating

Comments concerning needed replacements/repairs _____

_____

_____

_____

Part C: **Home exterior**

1. Are all components of the exterior properly caulked? Yes No

2. Are plumbing entries tightly sealed? Yes No

3. Are crawl-space entries tightly sealed? Yes No

4. Does the mail-slot close tightly? Yes No

5. Is the dryer outlet sealed tightly? Yes No

Part C: **Home exterior** (cont.)

6. Is/are air-conditioning outlet(s) tightly sealed? Yes No

7. Are all other exhaust outlets properly sealed? Yes No

Comments concerning needed replacements/repairs _____

_____

_____

_____

Part D: **Heating/air-conditioning system**

1. Is the heating system a forced-air system or a convection system?

_____

Air leaks affecting heating/air-conditioning system performance

Directions: If your home has a forced-air furnace, shut off the furnace if it is in use. Then, using the draft detector you have made, check for air leaks in all of the areas indicated below. After your inspection, be sure to turn the heat back on if necessary.

2. Are there leaks around any doors? Yes No

3. Are there leaks around any windows? Yes No

4. Are there leaks along any floors or floorboards? Yes No

5. Are there leaks in any corners where exterior walls come together? Yes No

6. Are there leaks around any plumbing entries under sinks/along exterior walls? Yes No

7. Are there any leaks around any electrical outlets on exterior walls? Yes No

8. Are kitchen and bathroom exhaust fans turned off when not needed? Yes No

Part D: **Heating/air-conditioning system** (cont.)

Other factors affecting heat/air-conditioning system performance

9.	During the months when the heating system is used, is the thermostat set at 65 degrees F (or lower) during the daytime hours?	Yes	No
10.	When the heating system is in use, is the thermostat set back to a lower temperature at night?	Yes	No
11.	In the months when the air-conditioning system is used, is the thermostat set at 78 degrees F (or higher) during the daytime hours?	Yes	No
12.	Are heating and cooling vents clean and unblocked?	Yes	No
13.	If there are filters on the heating/air-conditioning system, are they clean and unclogged?	Yes	No
14.	Is the ductwork insulated?	Yes	No

Comments concerning needed changes in habits or replacements/repairs _____

_____

_____

_____

Part E: **Insulation**

1.	Is there any insulation in the attic/ceiling area?	Yes	No
2.	Is there any insulation in the walls?	Yes	No
3.	Is there any insulation in the floors/foundation?	Yes	No

Part E: **Insulation** (cont.)

4. Complete the chart below concerning the insulation in any of the areas marked "yes" on the previous page.

Area	Recommended R-value	Actual R-value
Attic/ceiling		
Walls		
Floors/foundation		

Comments concerning needed replacements/repairs _____

_____

_____

_____

Part F: **Lighting**

1. Are lights left on in rooms or areas when a room/area is not being used? Yes No

2. Are fluorescent bulbs used in light fixtures whenever possible? Yes No

3. Are walls a light color to provide good light reflection? Yes No

4. What kinds of natural lighting (windows, skylights, etc.) are available? (Fill in the blank lines provided below.)

_____

_____

_____

Comments concerning needed changes in habits or replacements/repairs _____

_____

_____

_____

Part G: Fireplace

1.	Is there a fireplace in the home?	Yes	No

If there is a fireplace(s). . .

2.	Is the vent always closed when the fireplace is not in use?	Yes	No
3.	Does the fireplace have glass doors to prevent heat loss?	Yes	No
4.	Does the fireplace have a method of circulating air and heat?	Yes	No

Comments concerning needed changes in habits or replacements/repairs _____

_____

_____

_____

Part H: Water heater

1. What is the average temperature of the hot water flowing from the hot-water faucets in the house? (Fill in the blank below.)

   Average temperature _____

2.	Are hot-water pipes insulated?	Yes	No
3.	Are all water heaters insulated?	Yes	No
4.	Are any hot-water faucets leaking?	Yes	No
5.	Are flow restrictors used on shower heads?	Yes	No
6.	Are flow restrictors used on sink faucets?	Yes	No

Comments concerning needed replacements/repairs _____

_____

_____

_____

Optional Assignment Sheet 3—Solve Problems Involving Energy and Power Measurement

Name _____ Date _____

Evaluation criteria	Rating
Directions have been followed.	_____
80% of questions have been answered correctly.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____

Part A **Calculate work.**

Introduction

In this unit, you have learned that power must be transmitted and controlled to do useful work. You have also learned that the definition of *energy* is "the ability to do work." But, what exactly is meant by *work*?

That may sound like a silly question. We all know what work is, and we all know, for example, how an engine can be used to do work in an automobile or to power a boat. But, you must have a more exact understanding of work and the ways work is measured in order to evaluate whether the equipment/machines you do work with are doing as much work as they are supposed to do.

Scientists define *work* as "the result of a force moving an object over a distance." For example, if you lift a book from a desk and raise it 2 feet, you have done work. You have applied enough force to move the book a distance of 2 feet. If you continue to hold the book in that position, no work is done. You may get tired, and your hands may sag from the weight of the book, but you still have not done any work because you did not apply a force to cause the book to move over a distance. That too may seem silly, but the point is to develop a definition of work that can be measured.

Work is measured in terms of force and distance. In fact, you can write a mathematical formula for determining the amount of work done by multiplying the amount of force required to move an object times the distance the object moves, or

Work = Force x Distance.

Optional Assignment Sheet 3

The idea of measuring distance is probably pretty clear to you. You know how to measure work distance in many units of measure: feet, inches, miles, meters, centimeters, kilometers, etc. The usual unit of measure for work is feet for the U.S. customary system, or meters for the metric system.

The measurement of force is probably less clear to you. As used in our definition of work, force is moving an object at an ever-increasing speed and is measured as the mass (weight) of the object times the rate at which the speed is increased. In other words, *force* is the "measurement of accelerating the weight of an object." The force you applied in lifting the book 2 feet can be determined by knowing how much the book weighs and how rapidly you raised it.

Unfortunately, for most of the work we do, there are multiple forces acting on the object being moved. For example, the force required to accelerate a car is not simply a matter of how much the car weighs and how fast it accelerates because other forces are at work. There are the effects of gravity, friction, air resistance, and other factors. These multiple forces are called *concurrent forces.* The force that we need to know for calculating work is the net result of all of these forces, a value known as *resultant force.* Because this value has to be derived scientifically, the value of force will be provided to you in the problems in this assignment sheet.

Force is measured in poundals in the U.S. customary system and in newtons in the metric system. A *poundal* is "the force required to increase the speed of a pound of mass 1 foot per second for every passing second." A *newton* is "the force required to accelerate a kilogram of mass 1 meter per second for every passing second."

Because work is the measurement of force and distance, the normal U.S. customary measurement for work is the foot-poundal, or *foot-pound* as it is more commonly called. The usual metric unit of measurement for work is the newton-meter.

Exercise

Directions Read the problems below and on the next page. Use the formula for calculating work to solve the problems. Show your work in the spaces provided. Write your answers on the blanks provided.

1. How much work is done by an engine that drives a boat 1 mile (5,280 feet) with a force of 1300 pounds?

_____

2. The tip of a lawn-mower blade travels 3.5 feet on each revolution. If it takes 2.2 pounds of force to turn the blade, how much work is done on each revolution?

_____

3. The chain on a chain saw travels 0.9 meters on each revolution. How much work is done during 10 revolutions if it takes 0.5 newtons of force to turn the chain through one revolution?

_____

Part B **Calculate power.**

Introduction

Power is a measure of how quickly work is done, and as explained in the introduction to Part A above, work is a measure of force applied over distance. For example, powering an ultralight airplane 500 feet with 200 pounds of force results in 100,000 foot-pounds of work. Whether it takes 20 seconds or 10 seconds for the airplane to travel that distance, the same amount of work is done, but something must be different if the same amount of work is done in half the time. That difference is in the amount of power required. It takes more power to do the same amount of work in less time.

The mathematical formula for power is

Power = Work/Time.

In the example above, the power required to move the ultralight airplane 500 feet in 10 seconds is 10,000 foot-pounds per second, while the power required to do the same job in 20 seconds is 5000 foot-pounds per second. Foot-pounds per second is the standard unit of measure for power in the U.S. customary system of measurement.

Optional Assignment Sheet 3

Because these calculations can lead to such large numbers, it is convenient to use a unit of measure in which the numbers will not be so large. This unit is the horsepower. *Horsepower* is based on experiments done by James Watt, the inventor of the steam engine. He found that the average draft horse could raise a 550-pound weight 1 foot in 1 second. Thus, 1 horsepower is equal to 550 foot-pounds.

To fly the ultralight airplane in our example 500 feet in 10 seconds requires approximately 18.2 horsepower, using the mathematical formula for horsepower

Horsepower = Work/Time in Seconds x 550.

The metric-system unit of measure for power is newton-meters per second and is commonly called a *watt*. A more convenient way of stating power measurements in the metric system is to use kilowatts. One kilowatt is equal to 1000 newton-meters per second.

Sometimes, you will be required to convert power ratings between the two measurement systems. To do so, remember:

- 1 horsepower is equal to 746 watts (or 0.746 kilowatts),
- a watt is equal to 0.00134 horsepower, and
- a kilowatt equals 1.34 horsepower.

Exercise

Directions Read the problems below and complete the required calculations to solve them. Show your work in the spaces provided. Round your answers to the nearest tenth. Write your answers on the blanks provided.

1. A motorcycle travels 1000 feet in 21 seconds. If a force of 460 pounds is applied, what is the horsepower required?

   Horsepower = _____

2. A technician is working on a foreign-made engine that is rated 3.7 kilowatts. What is its approximate horsepower rating?

   Horsepower = _____

Optional Assignment Sheet 3

3. A boat engine is capable of generating 480 newton-meters of force while moving the boat 1000 meters in 2 minutes. How many kilowatts of power are developed?

   Kilowatts = _____

Part C **Calculate torque.**

Introduction

Torque is the term used to describe the twisting force exerted on an object. For example, torque is developed by an engine as it converts chemical energy into rotary power. Torque is exerted on a bolt as a person tightens it. The rotating blade of a lawn mower, the propeller of a boat motor, and the wheels of a motorcycle are all other examples of this force called *torque*.

All of the above examples have one thing in common: they each involve an object rotating around a center point. Such a center point is called an *axis*. Torque is calculated as an amount of force applied at a specific distance from the axis. The mathematical formula for torque is

Torque = Force x Radius,

where the radius is the distance between the point where the force is applied and the axis.

As with other formulas we have studied, force is measured in pounds and distance is measured in feet, or sometimes in inches. The unit of measure for torque is pound-feet or pound-inches. Be careful not to confuse this measurement with the foot-pound unit of measure for work.

Exercise

Directions

Read the problems below and on the next page. Use the formula for torque to solve the problems. Show your work in the spaces provided. Round your answers to the nearest tenth. Write your answers on the blanks provided.

1. An 18-inch rotary lawn-mower blade turns with a force of 2.5 pounds at the tip of the blade. How much torque is generated?

   _____

Optional Assignment Sheet 3

2. To tighten a bolt, a person applies 10 pounds of force to the end of a wrench that is 8 inches long. How much torque is applied to the bolt?

_____

3. If a 6-inch pulley drives a belt with 35 pounds of force, how much torque is developed?

_____

4. Two gears engage each other with a force of 24 pounds. Gear A is 6 inches in diameter, and Gear B is 4 inches in diameter. What is the torque developed on the axis of each gear?

   a. Gear A _____

   b. Gear B _____

Answers to Assignment Sheets

Answers to required assignment sheets in student edition

Assignment Sheet 1—Answers will vary. Student performance should be evaluated according to the criteria listed on the assignment sheet.

Assignment Sheet 2—Answers will vary. Student performance should be evaluated according to the criteria listed on the assignment sheet.

Answers to optional assignment sheets in teacher edition

Assignment Sheet 1

Part A—AIT media, "Introduction to Energy"

1. *Energy* is the ability to do work.
2. The three supply categories in which energy sources are grouped are:
   - exhaustible sources, which are fossil fuels (coal, oil, natural gas), and uranium,
   - renewable sources, which are the animal-, plant-, and waste-products associated with bioconversion, and
   - inexhaustible sources, which are wind, sun, water, and geothermal.
3. **Coal** is used to fire boilers at electrical power-generation plants.

   Oil powers most transportation; diesel, gasoline, and jet fuel are made from oil.

   Natural gas is used primarily for heating and cooking, but also for processing other materials.
4. Exhaustible

   Exhaustible sources are running out, and these sources also contribute to pollution and environmental problems such as acid rain.
5. *Bioconversion* is the process of obtaining the energy from plant, animal, and waste products.

   Bioconversion is an inefficient process because a relatively small amount of energy can be produced from the process.

   The chief benefits of the bioconversion process are that plant and animal products are a renewable source of energy, and that it is also a way of converting waste materials to a useful purpose.
6. Some possible responses include pollution as well as a better standard of living.

7. In transportation:

   - drive energy-efficient cars,
   - drive at speeds that cause your car to burn less fuel, and
   - car-pool or use mass-transit vehicles.

   In designing, building, and living in homes:

   - insulate homes and
   - use energy-efficient appliances.

8. Some examples of abundant sources of clean energy are

   - nuclear fusion from seawater,
   - solar power, and
   - wind power.

Part B—AIT media, "Energy Conversion and Measurement"

1. We convert energy into power to make energy useful.

2. The six forms of energy are

   - heat,
   - light,
   - chemical,
   - mechanical,
   - electrical, and
   - nuclear.

   The most portable form of energy and the form most closely associated with stored energy is chemical energy (batteries and fuels such as gasoline and oil).

3. a. Photovoltaic cells
   b. Battery
   c. Burning oil for home heat
   d. Electric motor

4. a. Coal (chemical energy) is burned (thermal energy) to produce steam to turn a turbine (mechanical energy) to produce electricity (electrical energy), which is transmitted to our laboratory light, where the light bulbs convert it to light (radiant energy).

   b. **Input:** Food provides the necessary fuel in the form of chemical energy.

      Process: The chemical energy is converted to mechanical energy through the use of muscles.

      Output: The person moves forward.

      Feedback: The body tells the brain if it is tired or needs more fuel.

5. *Potential energy* is stored energy, which is easily converted and available for use as kinetic energy. An example of potential energy is water that is held behind a dam.

   Kinetic energy is energy in motion. An example of kinetic energy is the movement of water through the gates of the dam.

6. The heat given off by an automobile engine and the heat going up a chimney are examples of *wasted energy*.

7. It is important to measure energy:

   - to reduce energy waste,
   - to determine how much work can be accomplished with the energy available, and
   - to convert the right amount of potential energy to kinetic energy.

   The measurement terms discussed in the media program include

   - *force*—any push or pull on an object,
   - *work*—useful motion that results in something being done,
   - *torque*—the measure of twisting or turning efforts,
   - *pressure*—the force per unit of area,
   - *BTU*—the measure of the heat necessary to raise the temperature of water, and
   - *horsepower*—a measure of power.

Part C—AIT media, "Power Transmission, Control, and Storage"

1. The most common changes in movement are

   - on/off switching,
   - change of direction,
   - change in speed, and
   - change in force.

2. **Manufacturing**—changing the speed of drills; changes in temperature required for processing materials

   Construction—controlling the flow of water and electricity in a home

   Communication—strength of the signals broadcast from a radio station; the amount of light for processing film

   Transportation—forward and reverse gears, steering, braking or accelerating, and turning on or shutting down the ignition

3. The four power systems are

   - mechanical,
   - fluid,
   - electrical, and
   - thermal.

4. **Mechanical**—pulleys, belts, gears, brakes

   Fluid—valves, transmission lines, cylinders and motors

   Electrical—switches and regulators, conductors and insulators, solenoids and motors

   Thermal—conductors and insulators

5. Mechanical, electrical, and fluid systems were demonstrated with the model blimp.

6. A catapult provided sufficient speed to launch the aircraft safely, and a tail hook on the aircraft caught a cable, transferring the energy of forward motion to the cable to stop the plane quickly enough to land safely and successfully.

7. **Mechanical**—coiled springs

   Fluid—compressed-air tanks

   Electrical—batteries, solenoids, and motors

   Thermal—chemical energy stored in matches, charcoal, and other fuels

Part D—AIT media, "Transportation Systems"

1. *Transportation* is the movement of people and things.

2. Examples of transportation are

   - moving people from one floor to another,
   - moving people and goods from one city to another,
   - transporting liquids through a pipeline, and
   - transporting bank information from a distant drive-in location.

3. Transportation occurs on land, water, and air and in space.

4. Some of the major technological developments in transportation were

   - the wheel,
   - the steam engine,
   - trains and railroads,
   - the automobile, and
   - the airplane.

5. Federal Express makes use of planes, trucks, vans, conveyor belts, small tractors, and elevator systems. The company monitors the subsystems with a "tracker." Optimum use of each system involved ensures that goods are moved faster and more efficiently than ever before.

6. In the future, we will travel faster and farther using less energy. There may be magnetic levitation trains, space planes, efficient solar cars, and space shuttles that routinely travel to orbiting space stations.

7. Current problems in transportation include

   - the deterioration of the infrastructure,
   - overcrowding of airports and roads, and
   - pollution.

8. The elevator is the safest form of public transportation.

Assignment Sheet 2—Answers will vary. Student performance should be evaluated according to the criteria listed on the assignment sheet.

Assignment Sheet 3

Part A—Calculate work.

1. 6,864,000 foot-pounds
2. 7.7 foot-pounds
3. 4.5 newton-meters

Part B—Calculate power.

1. 39.8 horsepower
2. 5 horsepower
3. 4 kilowatts

Part C—Calculate torque.

1. 22.5 pound-inches or 1.9 pound-feet
2. 80 pound-inches or 6.7 pound-feet
3. 105 pound-inches or 8.8 pound-feet
4. a. 72 pound-inches or 6 pound-feet
   b. 48 pound-inches or 4 pound-feet

Optional Lab Activity Sheet 1—Construct a Pneumatic Third-Class Lever

Introduction

As you learned in Objective 12 of the information sheet, fluid power systems are one of the four types of power systems used to control and transmit power. Fluid power systems are based on the idea of putting either a liquid or a gas under pressure to transmit and control power. Fluid power systems that use a gas (usually air) are called *pneumatic* systems. Fluid power systems that use a liquid (usually water or oil) are called *hydraulic* systems.

In this lab activity sheet, you will construct a third-class lever that is pneumatically powered and use the lever to do work in order to help you better understand the principles behind a pneumatic fluid power system.

Equipment and materials

Your instructor will provide you with the following materials:

- Two cardboard tubes, roughly the same length and diameter
- Piece of flat cardboard
- Pencil
- Cutting tool (such as an X-acto knife) for cutting the cardboard
- 1-foot length of ½-inch flexible plastic tubing
- Plastic squeeze bottle
- Small balloon
- Duct tape

Procedure

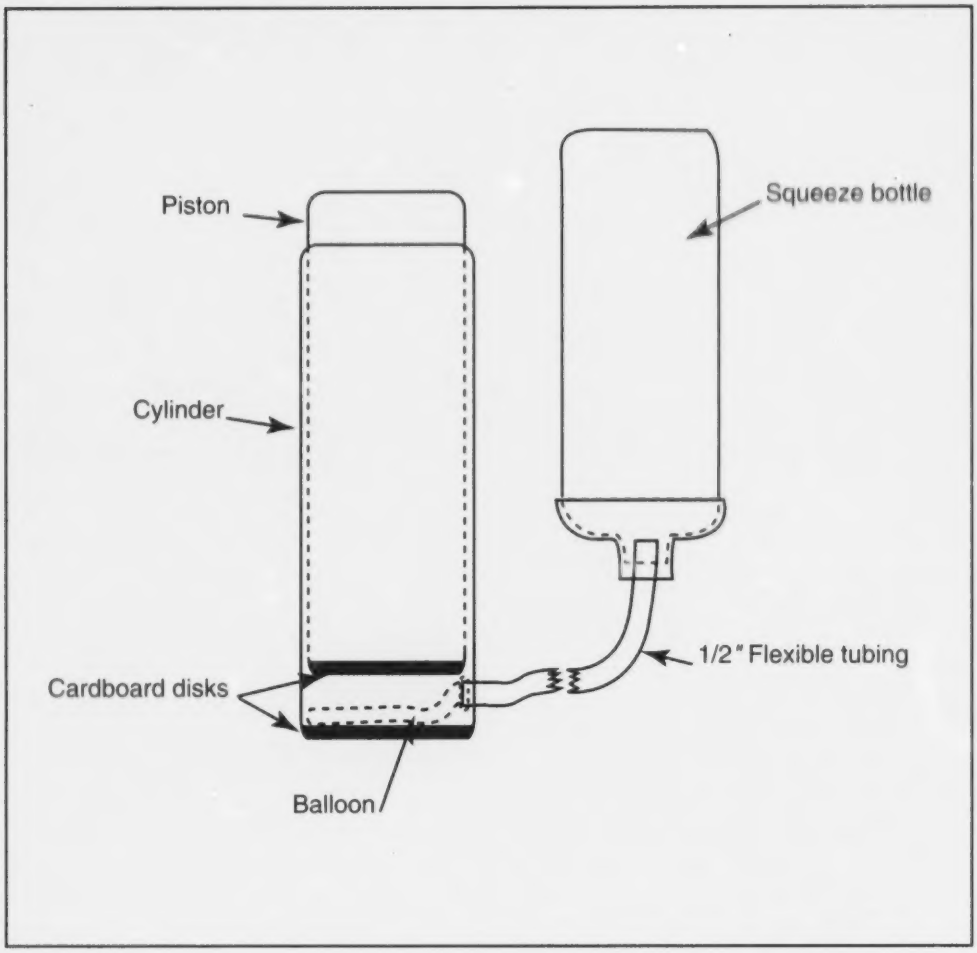
Put a checkmark on the blank line before each step below as you complete it.

_____ 1. Review the worksheet associated with this lab activity, which begins on page 51.

_____ 2. **Assemble the components of the pneumatic cylinder:**

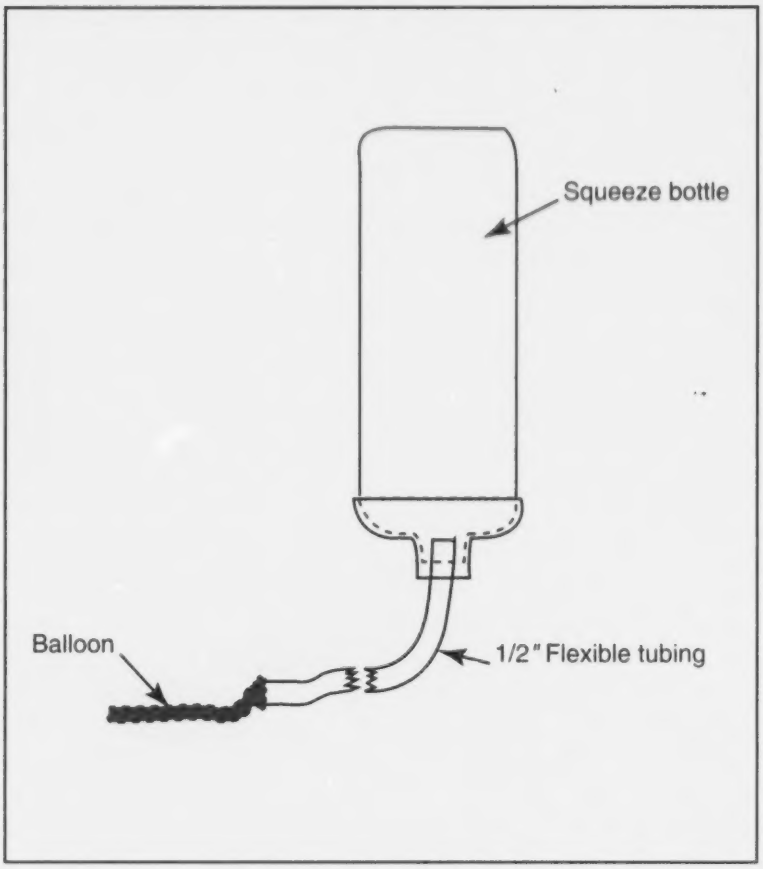
- Study the diagram of the completed pneumatic-cylinder setup in Figure 1 on the next page.

Figure 1: Completed pneumatic-cylinder setup



- Assemble the balloon/tubing/squeeze-bottle component:
  - — Insert the ½-inch flexible plastic tubing about ½ inch into the neck of the balloon (see Figure 2 on the next page).
  - — Securely duct-tape the balloon to the plastic tubing, creating an air-tight seal.
  - — Insert the other end of the flexible plastic tubing into the mouth of the plastic squeeze bottle (see Figure 2).
  - — Securely duct-tape the plastic tubing in the mouth of the squeeze bottle, creating an air-tight seal.

Figure 2: Balloon/tubing/squeeze-bottle component

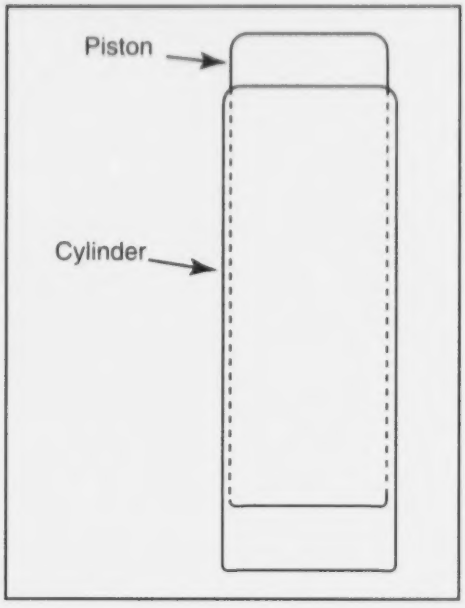


- Assemble the piston/cylinder component:

  — Slit one of the two cardboard tubes lengthwise, and then, duct-tape it back together so that it has a slightly smaller diameter than before and will now fit inside the other cardboard tube (see Figure 3 on the next page).

  The smaller-diameter tube will be the *piston* of the completed pneumatic-cylinder component, and the larger-diameter tube will be the *cylinder* (see Figure 3).

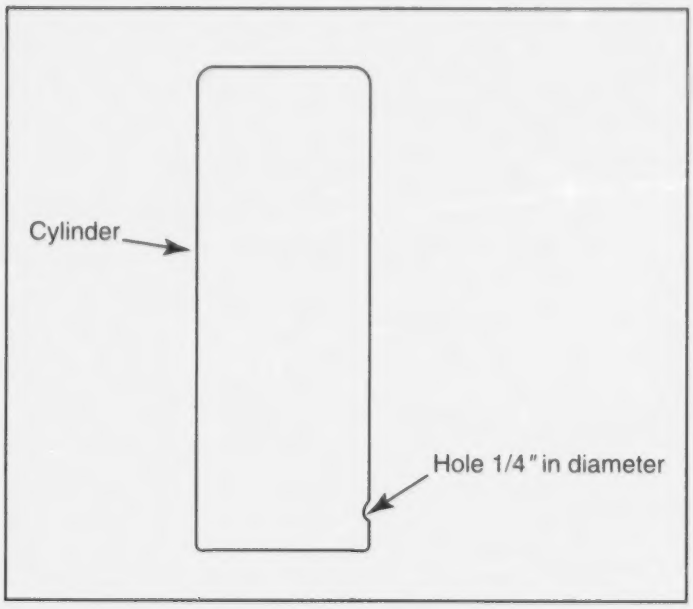
Figure 3: Piston/cylinder component



_____ 3. **Complete the pneumatic-cylinder setup:**

- Near one end of the cardboard cylinder, cut a hole about ¼ inch in diameter (see Figure 4)

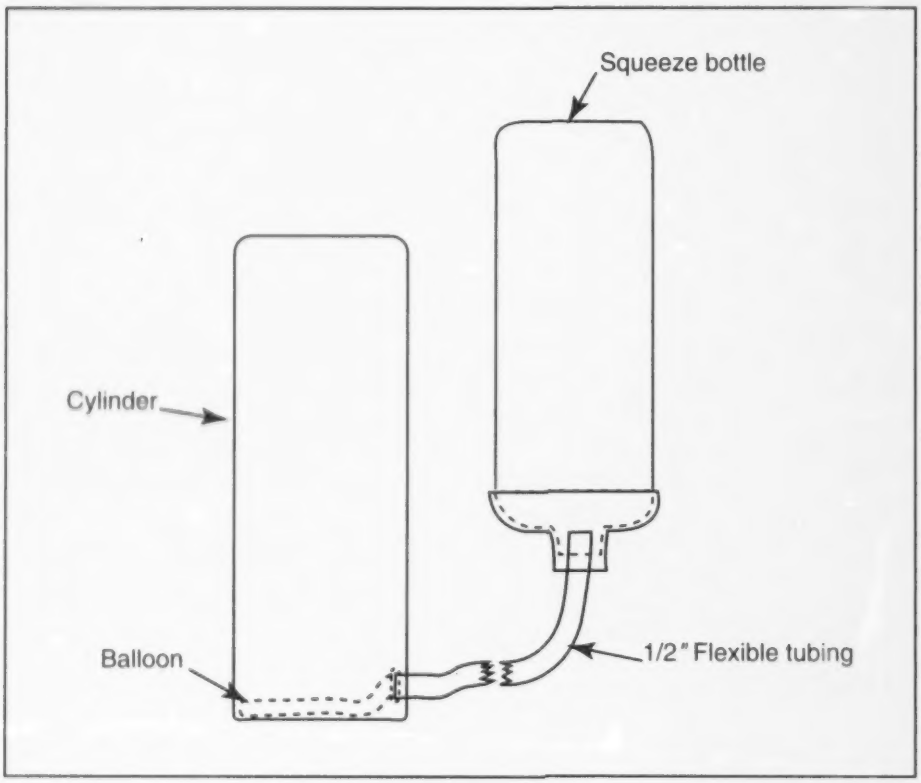
Figure 4



- Work the end of the balloon of the balloon/tubing/squeeze-bottle component into the hole in the cylinder, pulling the balloon into the cylinder until the flexible plastic tubing butts the side of the cylinder (see Figure 5).

- Securely duct-tape the tubing in place against the side of the cylinder (see Figure 5).

Figure 5



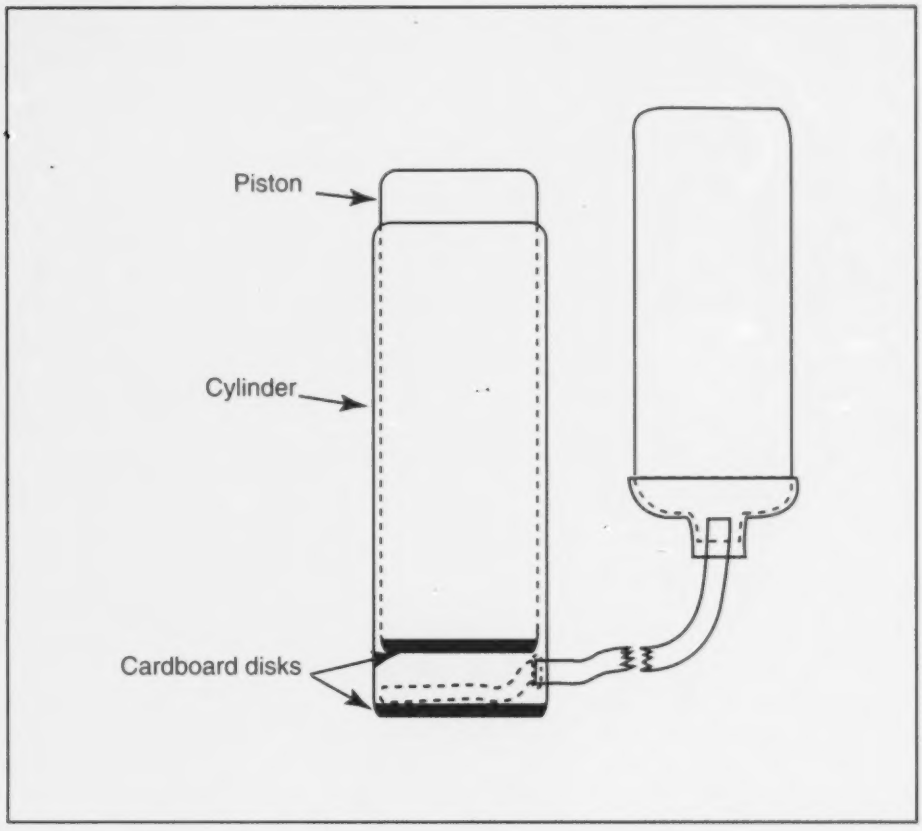
- Place one end of the piston on the piece of flat cardboard, and using the pencil, draw the outline of the circumference of the piston on the flat cardboard.

- Cut the piston outline out of the flat cardboard to create a cardboard disk, and duct-tape the disk to one end of the piston (see Figure 6 on the next page).

- Place one end of the cylinder on the piece of flat cardboard, and using the pencil, draw the outline of the circumference of the cylinder on the flat cardboard.

- Cut the cylinder outline out of the flat cardboard to create a cardboard disk, and duct-tape the disk to the end of the cylinder that contains the balloon (see Figure 6).

Figure 6



- Stand the cylinder balloon-end down on your work surface and duct-tape the cylinder to the work surface.
- Insert the piston disk-covered end down into the cylinder (see Figure 6).

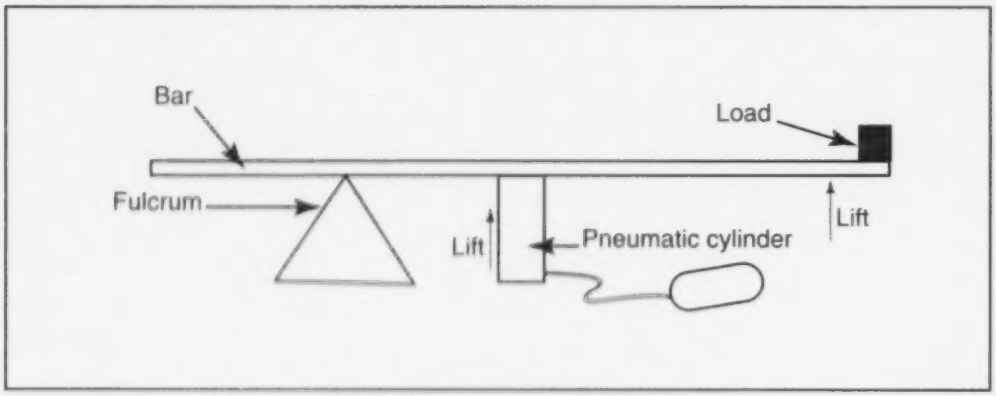
_____ 4. **Test your pneumatic cylinder:**

- Squeeze the plastic bottle. *If* your pneumatic cylinder is working properly, squeezing the plastic bottle should inflate the balloon inside the cylinder, which should cause the piston to lift.
- Make adjustments to correct the pneumatic-cylinder assembly as necessary until it functions properly.

_____ 5. **Construct the third-class lever:**

- Study the lever diagram in Figure 7.
- Make a "bar" from the flat cardboard.
- Make a "fulcrum" from the flat cardboard. The height of your completed fulcrum should be the same as, or slightly higher than, the height of the pneumatic cylinder (see Figure 7).

Figure 7: Lever diagram



_____ 6. **Test the third-class lever:**

- Place a load of no more than 5 ounces on the end of the lever's bar (see Figure 7).
- Squeeze the plastic bottle, which will inflate the balloon, which should cause the piston to lift, which in turn should lift the lever bar and the load.
- Allow the balloon in the pneumatic cylinder to deflate, which should cause the piston to move down in the cylinder, which should in turn cause the lever bar and the load to drop.
- Make adjustments to the lever as necessary until it functions properly.

_____ 7. Complete the pre-performance check for the procedure (Part A) on the worksheet and receive your instructor's signed approval for the completed pneumatic-cylinder/third-class lever assembly.

_____ 8. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

_____ 9. Have your instructor watch you lift the load with your pneumatic-cylinder/third-class lever assembly. Your instructor will rate your performance using the criteria listed in Part B.

_____ 10. Turn in your completed worksheet to your instructor.

Optional Lab Activity Sheet 1

Worksheet—Construct a Pneumatic Third-Class Lever

Name _____ Attempt number _____

Date _____

Part A: Pre-performance check

Your instructor's signature below, indicates that you have correctly constructed the pneumatic cylinder and third-class lever and are ready to perform the test.

If your pneumatic cylinder or third-class lever requires improvements and corrections, your instructor will indicate those in the space below.

Instructor's signature _____

Optional Lab Activity Sheet 1

Worksheet—Construct a Pneumatic Third-Class Lever

Part B: Performance evaluation

Evaluation criteria	**Rating**
Procedure was completed correctly and accurately.	_____
Worksheet was completed correctly and accurately.	_____
Clean-up and follow-up actions were adequate.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____

Exploring Energy, Power, and Transportation Technology

Written Test

Name _____ Score _____

1. Match terms associated with energy and power to their correct definitions. Write the numbers on the blanks provided.

_____	a.	Application and control of force through the use of mechanical means	1. Energy
_____	b.	Movement as a result of applied force	2. Force
_____	c.	The rate at which work is done or energy is transmitted	3. Work
_____	d.	The ability to do work	4. Power
_____	e.	Agent that causes motion or causes a change in the direction or speed of an object in motion	5. Motion
_____	f.	State of an object changing its location in space	6. Mechanical force

2. Define the stages in a basic technology systems model. Write your answers on the blank lines provided beside each of the stages listed below.

a. **Stage 1: Input** _____

_____

_____

b. **Stage 2: Process** _____

_____

_____

c. **Stage 3: Output** _____

_____

_____

d. **Stage 4: Feedback** _____

_____

_____

3. Match the forms of energy to their correct descriptions. Write the numbers on the blanks provided.

_____	a. Energy contained in photons	1. Nuclear energy
_____	b. Energy released by breaking the bonds within the nucleus of atoms	2. Light energy
_____	c. Energy released by changing how the atoms or molecules within a substance are bonded to each other	3. Heat energy
_____	d. Energy of the motion of atoms and molecules	4. Electrical energy
_____	e. Energy that is transmitted through the movement of objects	5. Chemical energy
_____	f. Energy flow at the atomic level due to the differences in the balance of electrons between atoms	6. Mechanical energy

4. List types of exhaustible, inexhaustible, and renewable sources of energy. Write your answers on the blank lines provided with each of the sources of energy listed below.

Exhaustible sources of energy

a. _____

b. _____

Inexhaustible sources of energy

a. _____

b. _____

c. _____

d. _____

Renewable sources of energy

a. _____

b. _____

5. List the goals of energy and power technology. Write your answers on the blanks provided below.

   a. _____

   _____

   b. _____

   _____

6. Define the classes of energy. Write your answers on the blanks provided beside each of the terms below.

   a. **Kinetic energy** _____

   b. **Potential energy** _____

7. State the characteristics of energy. Write your answers on the blanks provided below.

   a. _____

   b. _____

   c. _____

8. Complete the following statements concerning the conversion of energy to power and the transmission of power to do work. Write your answers on the blank line(s) in each of the statements below.

   a. Energy is useful only when it is converted into _____.

   b. The conversion of energy involves some loss, often as _____ energy.

   c. Because some energy is lost when it is converted, we need to be able to _____ and _____ it.

   d. Power must be transmitted to do useful _____.

   e. To be used effectively, power must be _____.

   f. Power can be _____ for later use.

9. Define the types of energy conversions. Write your answers on the blank lines provided beside each of the terms below.

   a. **Direct conversion** _____

   _____

   b. **Indirect conversion** _____

   _____

10. Define the types of motion. Write your answers on the blank lines provided beside each of the terms below.

    a. **Linear** _____

    b. **Rotary** _____

    c. **Reciprocating** _____

11. State the characteristics of motion. Write your answers on the blank lines provided below.

    a. _____

    _____

    b. _____

    _____

    c. _____

    _____

12. List the types of power systems used to control and transmit power. Write your answers on the blank lines provided below.

    a. _____

    b. _____

    c. _____

    d. _____

13. Define the term *transportation*. Write your answer on the blank line provided beside the term below.

    Transportation _____

14. State the goal of transportation technology. Write your answer on the blank lines provided below.

    _____

    _____

15. Define the types of transportation systems. Write your answers on the blank lines provided beside each of the terms below.

a. **Stationary system** _____

_____

b. **Land system** _____

_____

c. **Water system** _____

_____

d. **Air system** _____

_____

e. **Space system** _____

_____

f. **Intermodal system** _____

_____

Permission to duplicate this test is granted.

Answers to Written Test

1.

a.	6	d.	1
b.	3	e.	2
c.	4	f.	5

2.

a. The means by which or the point at which something is put into a system

b. A series of actions or operations occurring in a system

c. Something produced by a system

d. The return to the input stage with evaluative or corrective information about the system processes and output

3.

a.	2	d.	3
b.	1	e.	6
c.	5	f.	4

4. **Exhaustible sources of energy**

Answers may appear in any order.

- Fossil fuels
- Uranium

Inexhaustible sources of energy

Answers may appear in any order.

- Solar energy
- Wind energy
- Hydro energy
- Geothermal energy

Renewable sources of energy

Answers may appear in any order.

- Energy from biomass conversion of plant materials
- Energy from biomass conversion of animal products

5. Answers may appear in any order.

- To harness the inexhaustible and renewable sources of energy and learn to use them effectively
- To conserve the exhaustible sources of energy by using them as efficiently as possible

Answers to Written Test

6. a. Energy in motion

   b. Energy at rest

7. Answers may appear in any order.

   - Energy is always present.
   - Energy cannot be created or destroyed.
   - Energy can only be changed from one type to another.

8. a. power

   b. thermal

   c. measure; monitor

   d. work

   e. controlled

   f. stored

9. a. An energy conversion that requires only one conversion before the energy is in the right form to do work

   b. An energy conversion that requires more than one conversion before the energy is in the right form to do work

10. a. Motion along a straight line

    b. Motion along a circle

    c. Motion that follows a repeated pattern

11. Answers may appear in any order.

    - An object in motion will continue in motion and an object at rest will stay at rest unless acted upon by another force.
    - A force can change the velocity of an object if the force is greater than the momentum of the object.
    - For every action, there is an equal and opposite reaction.

Answers to Written Test

12. Answers may appear in any order.
    - Mechanical power system
    - Electrical power system
    - Fluid power system
    - Thermal power system

13. The movement of people and things

14. To move people and things greater distances at greater speeds with less expenditure of energy

15. a. System in which a vehicle remains in one place while moving people/things within the system
    b. System that moves people/things in vehicles that travel on land
    c. System that moves people/things in vessels that travel through water
    d. System that moves people/things in vehicles that travel through the air
    e. System that moves people/things in vehicles that travel into outer space
    f. System that uses more than one of the above types of transportation systems to move people/things

Exploring Energy, Power, and Transportation Technology

Unit Evaluation Form

Student name _____ Unit rating _____

Assignment-sheet ratings

Assignment Sheet 1—Research a Career in Energy, Power, and Transportation Rating _____

Comments: _____

_____

Assignment Sheet 2—Analyze a Transportation System in Your Local Area Rating _____

Comments: _____

_____

Lab-activity-sheet ratings

Lab Activity Sheet 1—Create and Test a Simple Device for Storing Energy Rating _____

Comments: _____

_____

Lab Activity Sheet 2—Construct and Evaluate the Effectiveness of Two Simple Solar Collectors Rating _____

Comments: _____

_____

Lab Activity Sheet 3—Construct and Analyze the Operation of an Energy-Conversion Simulator Rating _____

Comments: _____

_____

Lab Activity Sheet 4—Design, Construct, and Evaluate a Water-Powered Lifting/Lowering Device Rating _____

Comments: _____

_____

Continue to back of this page.

Unit Evaluation Form

Lab Activity Sheet 5—Design, Construct, and Evaluate a Wind-Powered Delivery Device Rating _____

Comments: _____

_____

List optional assignments and ratings.

Written test scores

Pretest _____ Posttest _____ Other _____

Comments _____

_____

Teacher signature _____ Date _____

Student signature _____ Date _____

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Exploring TECHNOLOGY EDUCATION

Exploring Energy, Power, and Transportation Technology

Student Edition

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Exploring Technology Education:

Exploring Energy, Power, and Transportation Technology

Student Edition

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Exploring Energy, Power, and Transportation Technology

Objective Sheet

Unit objective

After completing this unit, the student should be able to define the stages in a basic systems model, discuss the goals of energy and power technology and transportation technology, and construct and evaluate simple devices that illustrate scientific principles associated with energy and power transmission. The student should demonstrate these competencies by completing the assignment sheets and lab activity sheets and by scoring a minimum of 85 percent on the written test.

Specific objectives

After completing this unit, the student should be able to

1. Match terms associated with energy and power to their correct definitions.
2. Define the stages in a basic technology systems model.
3. Match the forms of energy to their correct descriptions.
4. List types of exhaustible, inexhaustible, and renewable sources of energy.
5. List the goals of energy and power technology.
6. Define the classes of energy.
7. State the characteristics of energy.
8. Complete statements concerning the conversion of energy to power and the transmission of power to do work.
9. Define the types of energy conversions.
10. Define the types of motion.
11. State the characteristics of motion.
12. List the types of power systems used to control and transmit power.
13. Define the term *transportation.*
14. State the goal of transportation technology.
15. Define the types of transportation systems.
16. Research a career in energy, power, and transportation. (Assignment Sheet 1)
17. Analyze a transportation system in your local area. (Assignment Sheet 2)
18. Create and test a simple device for storing energy. (Lab Activity Sheet 1)

Objective Sheet

19. Construct and evaluate the effectiveness of two simple solar collectors. (Lab Activity Sheet 2)
20. Construct and analyze the operation of an energy-conversion simulator. (Lab Activity Sheet 3)
21. Design, construct, and evaluate a water-powered lifting/lowering device. (Lab Activity Sheet 4)
22. Design, construct, and evaluate a wind-powered delivery device. (Lab Activity Sheet 5)

Exploring Energy, Power, and Transportation Technology

Information Sheet

1. Terms and definitions associated with energy and power

- **Energy**—The ability to do work

  Examples: Nuclear energy, electrical energy, light energy, heat energy, mechanical energy

  Note: The above definition of *energy* is the scientific definition of the word and may at first seem confusing. Most people think of energy as a power source, such as electricity or solar power. But energy is actually the characteristic of electricity or the characteristic of light or the characteristic of heat that allows work to be done by converting the energy into a force.

- **Force**—Agent that causes motion or causes a change in the direction or speed of an object in motion

  Examples: Gravity, wind, application of an automobile's brakes, rotating the steering wheel of an automobile

- **Work**—Movement as the result of applied force

  Note: By combining the definition of *work* with the definition of *energy*, it turns out that energy is the ability to cause movement as the result of applied force. Thus, energy must be capable of producing a force to cause movement.

- **Power**—The rate at which work is done or energy is transmitted

  Examples: Horsepower, torque, watts, roentgens, lumens

  Note: Power is a measure of work or of the movement of energy. Because work and the movement of energy both involve travel across distance, power is a measure of how much time it takes for the distance to be covered. The basic concept is that the greater the power, the less time required for the distance to be traveled.

- **Motion**—State of an object changing its location in space

  Note: Motion consists of four characteristics. The first of these characteristics is *speed*—that is, the rate at which the object changes location. The second characteristic is *direction*. Together, speed and direction are referred to as *velocity*. *Acceleration*, the third characteristic of motion, is a change in velocity. Acceleration can be positive (the object increases speed) or negative (the object decreases in speed). Negative acceleration is often called *deceleration*. The fourth characteristic is *momentum*. Momentum is a combination of velocity and the mass—or weight—of the object. The faster an object travels or the more weight it has, the greater is its momentum.

- **Mechanical force**—Application and control of force through the use of mechanical means

  Examples of mechanical means: Pulleys, gears, rods, belts, chains

Information Sheet

2. Stages in a basic technology systems model and their definitions

Note: A *systems model* is a visual representation that analyzes the stages (input, process, output, and feedback) in a technology system (see Figure 1).

- **Stage 1: Input**—The means by which or the point at which something is put into a system

  Note: Some of the inputs in an energy, power, or transportation system would include such things as energy sources, people's skills and knowledge, capital, and machines and facilities (see Figure 2 on the next page).

- **Stage 2: Process**—A series of actions or operations occurring in a system

  Note: The processes in an energy, power, or transportation system would include such things as the actions or operations involved in converting energy to power and the actions and operations involved in transmitting, controlling, and storing that power (see Figure 2).

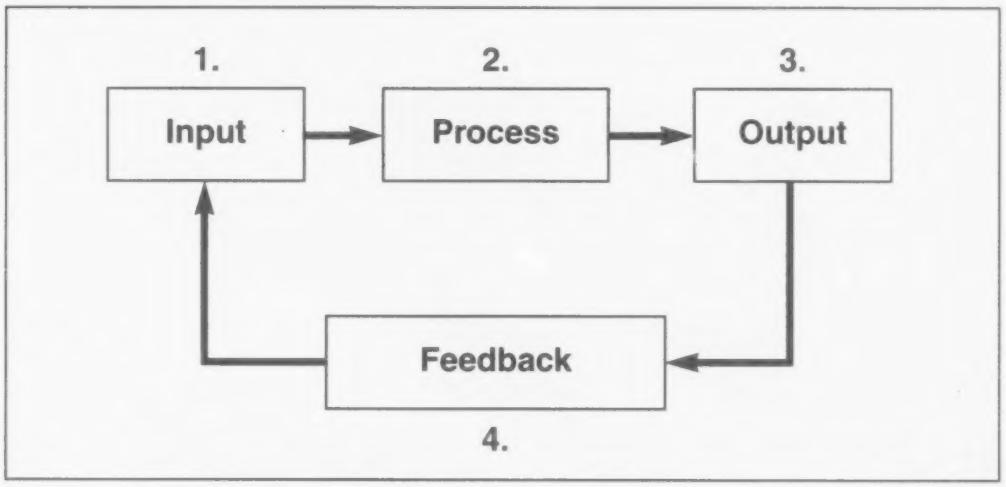
- **Stage 3: Output**—Something produced by a system

  Note: The output of an energy, power, or transportation system is the power to do work.

- **Stage 4: Feedback**—The return to the input stage with evaluative or corrective information about the system processes and output

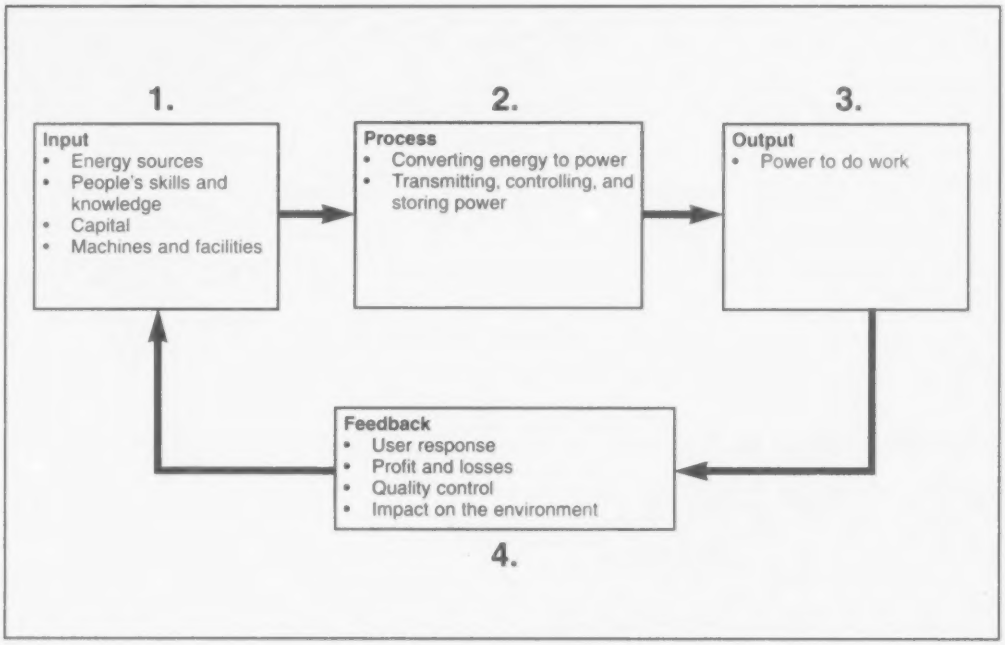
  Note: Feedback in a manufacturing system is provided by such things as user responses, profit and losses, quality control, and impact on the environment (see Figure 2).

Figure 1: Universal systems model



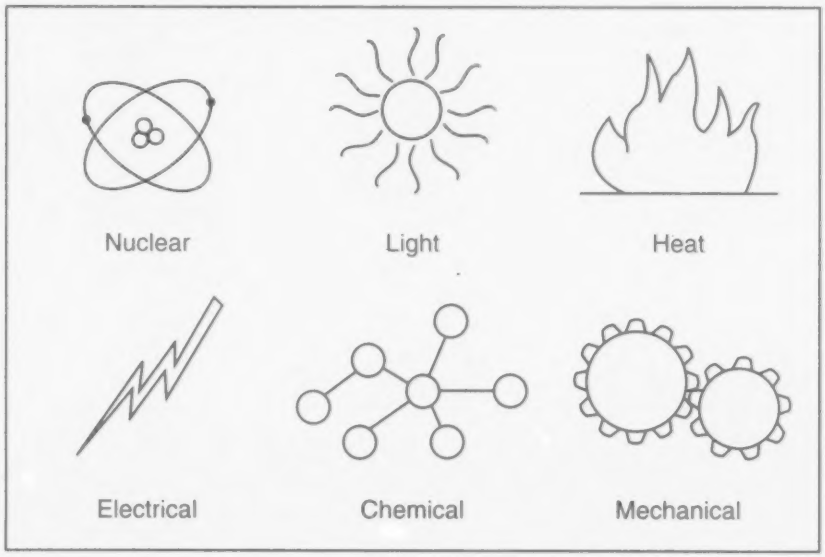
Information Sheet

Figure 2: Universal systems model showing the resources used in the various stages of a basic energy, power, or transportation system



3. **Forms of energy and their descriptions** (see Figure 3)

Figure 3: Forms of energy



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Information Sheet

- **Nuclear energy**—Energy released by breaking the bonds within the nucleus of atoms

  Note: Atoms consist of a nucleus and of electrons that orbit around the nucleus. The nucleus is composed of bits of matter called *protons* and *neutrons* that are tightly bonded to each other (see Figure 4-a on the next page). Nuclear energy—or atomic energy as it is also called—is developed by breaking the bonds within the atom's nucleus in a special device called a *reactor*. The nuclear energy is converted into heat and light energy, which can then be used for powering engines, for producing electricity, or for other purposes.

- **Light energy**—Energy contained in photons

  Note: Most scientists believe that light is something of a cross between particles called *photons* and the energy of the wave motion that photons follow.

- **Heat energy** (thermal energy)—Energy of the motion of atoms and molecules

  Note: All substances—what scientists call *matter*—consist of atoms and collections of atoms called *molecules*. Atoms and molecules are in constant motion. In matter, this motion is not movement across great distances but is instead small vibrations as the atoms and molecules "bump" into each other.

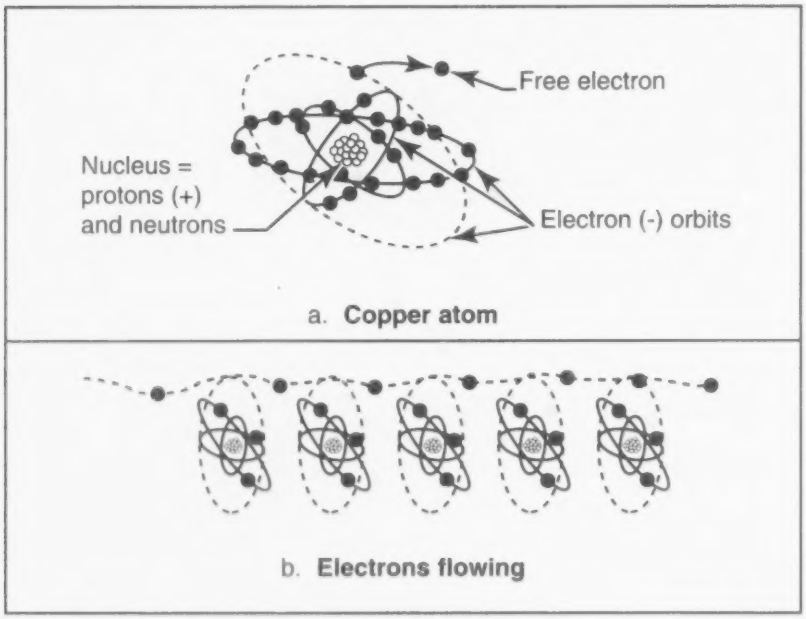
  There are physical laws that say that the whole universe is trying to reach the same level of heat energy—in other words, trying to reach the same temperature. For this reason, if two substances are at different temperatures and are in contact with each other, the cooler substance will get warmer through the transfer of heat from the warmer substance. That is why the air warms up as it is exposed to light energy from the sun. In effect, applying energy to matter makes the atoms and molecules move faster.

- **Electrical energy**—Energy flow at the atomic level due to the differences in the balance of electrons between atoms

  Note: The imbalance of electrons between atoms is called *charge*. A substance is said to have a *positive charge* if it has more protons than electrons and is said to have a *negative charge* if it has more electrons than protons. Protons are thought of as positive particles, electrons as negative particles, and neutrons as neutral particles (having no charge) (see Figure 4-a).

  In some substances, the electrons orbiting the nucleus of an atom can break away to wander in the space between atoms. These wandering electrons can also be captured by other atoms that they approach. By applying energy to the substance, the movement of electrons that can break away from one atom and be captured by another is increased. The movement of these electrons is then said to be made "to flow in a current" by applying an electromotive force (voltage) (see Figure 4-b).

Figure 4: Electron flow



- **Chemical energy**—Energy released by changing how the atoms or molecules within a substance are bonded to each other

  Note: All substances—solids, liquids, and gases—are composed of atoms. If a substance has only one kind of atom, it is called an *element*. If a substance is made of molecules of two or more different types of atoms, it is called a *compound*. For example, the compound water consists of two atoms of the element hydrogen and one atom of the element oxygen.

  Chemists use one- or two-letter abbreviations to represent each of the elements, and they represent compounds by combining these abbreviations into codes called *formulas*. For example, the code or formula for water is H_2O—that is, two hydrogen (H) atoms and one oxygen (O) atom.

  The energy that bonds atoms to each other as molecules can be released by applying energy and creating a chemical reaction. Because chemical energy cannot be easily used without converting it to another form of energy, such as heat or electrical, it is sometimes called *stored energy*.

- **Mechanical energy**—Energy that is transmitted through the movement of objects

  Note: Most equipment operation depends on converting some other form of energy into mechanical energy and directing and controlling the mechanical energy through mechanical means such as wheels, pulleys, gears, belts, chains, and connecting rods. The movement of your legs as you walk is an application of mechanical energy, as are the turning wheels of an automobile, the pressure of falling water, and the force of the wind.

Information Sheet

4. Types of exhaustible, inexhaustible, and renewable sources of energy

Note: *Exhaustible* sources of energy are those that cannot be replaced once they are used; *inexhaustible* sources of energy are those that will always be available; and *renewable* sources of energy are those that can be used indefinitely if they are properly managed and maintained. Inexhaustible and renewable sources of energy are also referred to as *alternative* sources of energy because they are being studied and developed as alternatives to exhaustible sources of energy.

- **Exhaustible sources of energy**

  — **Fossil fuels**

  Note: Fossil fuels (or *hydrocarbons*) are fuels that are derived from plants and animals that were deposited in the earth's surface millions of years ago and then fossilized. Examples of fossil fuels are natural gas, coal, and oil (petroleum).

  — **Uranium**

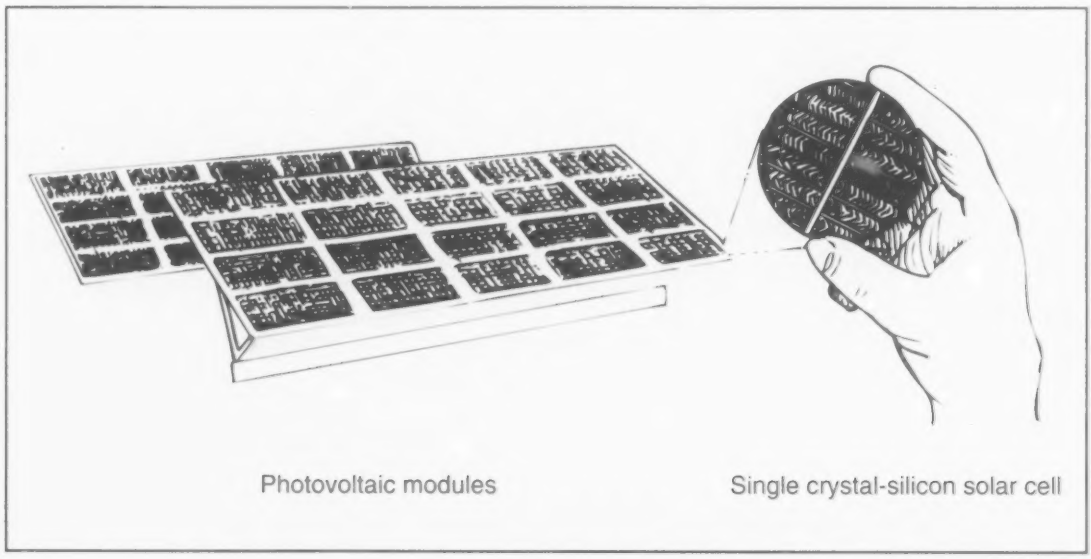
  Note: Uranium is a silvery, heavy radioactive element that when bombarded with slow neutrons undergoes rapid fission into smaller atoms with the release of neutrons and atomic energy, which is used in power plants and atom bombs.

- **Inexhaustible sources of energy**

  — **Solar energy**

  Note: Energy from the sun (solar energy) is being studied and developed to be used in passive and active applications to heat homes and businesses and to be turned into electricity when used with solar cells collected in photovoltaic modules (see Figure 5).

Figure 5: Solar cells used in photovoltaic modules

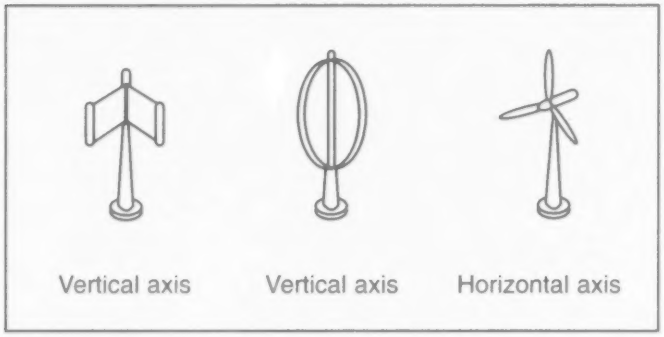


Information Sheet

— **Wind energy**

Note: Energy from the movement of air (wind energy) is being studied and developed to be used with modern wind machines that turn the energy in wind into electricity (see Figure 6).

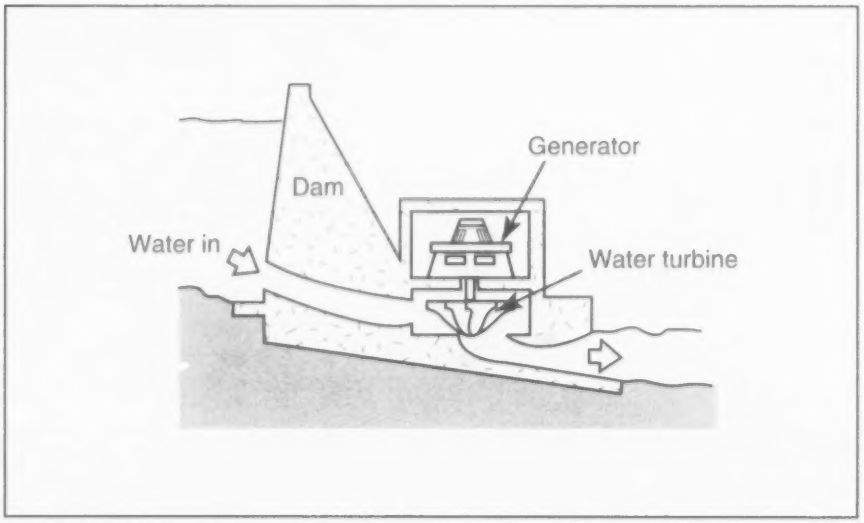
Figure 6: Types of wind machines



— **Hydro energy**

Note: Energy from the movement of water (hydro energy) is being used primarily to generate electricity. The force of falling or flowing water in rivers or streams is directed through a turbine, causing the turbine to spin. The spinning turbine then rotates a generator that produces electricity (see Figure 7). The force created by ocean waves and the rising and falling of ocean tides is also being studied and developed to turn turbines and generate electricity.

Figure 7: Generating electricity with a water turbine

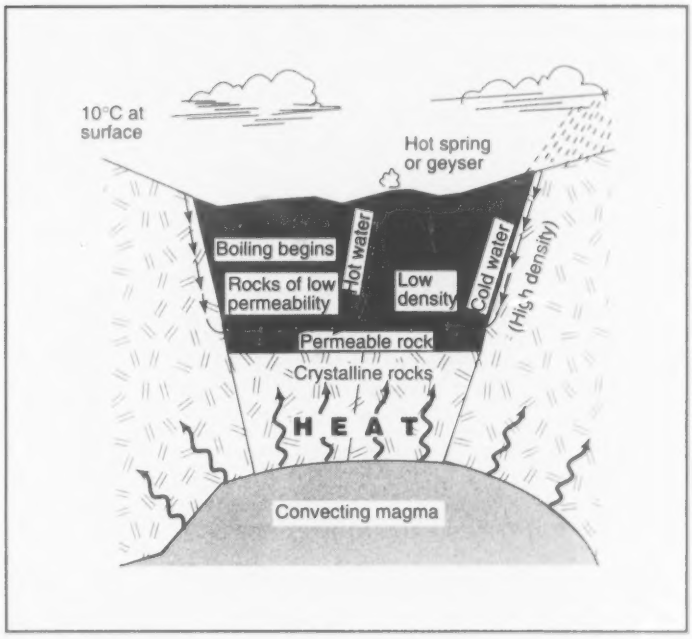


Information Sheet

— **Geothermal energy**

Note: Geothermal energy is a result of heat being generated by natural processes beneath the earth's surface and then stored in geothermal reservoirs such as volcanoes, hot springs, and geysers. Commercial power plants use the heat in these natural geothermal reservoirs to generate electricity (see Figure 8).

Figure 8: Diagram of a geothermal reservoir



- **Renewable sources of energy**

  — **Energy from biomass conversion of plant materials**

  — **Energy from biomass conversion of animal products**

  Note: The term *biomass* refers to waste products (such as manure, sewage, and garbage) and plant materials (such as trees, farm crops, seaweed, and algae). In *biomass conversion*, these waste products and plant materials are either burned and used as direct sources of heat to generate electricity or to propel vehicles of transportation, or are first converted into fuels (such as alcohol and methane), and then, these fuels are burned and used as sources of heat to generate electricity or to propel vehicles of transportation.

5. **The goals of energy and power technology**

   - **To harness the inexhaustible and renewable sources of energy and learn to use them effectively**

   - **To conserve the exhaustible sources of energy by using them as efficiently as possible**

Information Sheet

Note: The exhaustible sources of energy (coal, oil, natural gas, and uranium) pollute the environment as a result of their use. Technology has not yet developed methods to effectively harness the power of the inexhaustible and renewable sources of energy (wind energy, solar energy, hydro energy, etc.). Until technology learns to harness the sources of inexhaustible and renewable energy effectively, we must conserve the exhaustible sources of energy and lessen their impact on the environment by using them as efficiently as possible.

6. Classes of energy and their definitions

Note: Kinetic and potential energy as defined below are **not** two more forms of energy or sources of energy as discussed in Objectives 3 and 4. They are simply terms used to classify the types of energy discussed in Objective 3. Use the following mental image to picture the difference between the definitions given below: just as a person can be described as being awake or asleep, energy can be classified as being in motion or at rest.

- **Kinetic energy**—Energy in motion

  Examples: Light, a moving train, wind, a released spring, fire, a chemical reaction, electricity

- **Potential energy**—Energy at rest

  Examples: A train that is standing still, still air, a compressed spring, fuel, stable chemicals, a battery that is not hooked up to a load

7. Characteristics of energy

Note: The natural happenings of the universe work according to certain patterns that scientists describe as *laws*. In this objective, you will study three important laws that apply to energy, and in Objective 11, you will study three laws that apply to motion.

- **Energy is always present.**

  Note: Although it is possible to imagine an environment without any atoms (a complete vacuum) that is totally dark and has no heat (absolute 0° temperature), such an environment has never been known to exist, and scientists have yet to create such an environment.

- **Energy cannot be created or destroyed.**

- **Energy can only be changed (converted) from one type to another.**

8. Statements concerning the conversion of energy to power and the transmission of power to do work

Note: As you learned in Objective 1, *energy* is the ability to do work; *work* is movement as the result of applied force; and *power* is the rate at which work is done or energy is transmitted.

- **Energy is useful only when it is converted into power.**

Information Sheet

- **The conversion of energy involves some loss, often as thermal energy.**
- **Because some energy is lost when it is converted, we need to be able to measure and monitor it.**

  Note: Some ways of measuring the energy that is used or lost are force, power, work, torque, pressure, BTUs, and horsepower.

- **Power must be transmitted to do useful work.**

  Note: There are four basic types of transmission systems—mechanical, fluid, electrical, and thermal (see Objective 12).

- **To be used effectively, power must be controlled.**

  Note: Controlling power often means stopping, starting, or changing the direction of a force.

- **Power can be stored for later use.**

9. **Types of energy conversions and their definitions**

   - **Direct conversion**—An energy conversion that requires only one conversion before the energy is in the right form to do work

     Example: Solar cells convert sunlight directly into electricity.

   - **Indirect conversion**—An energy conversion that requires more than one conversion before the energy is in the right form to do work

     Example: An automobile engine (a gas-powered internal-combustion engine) converts fuel (chemical energy) into heat energy during combustion, then the heat energy is converted into mechanical energy to move gears and wheels.

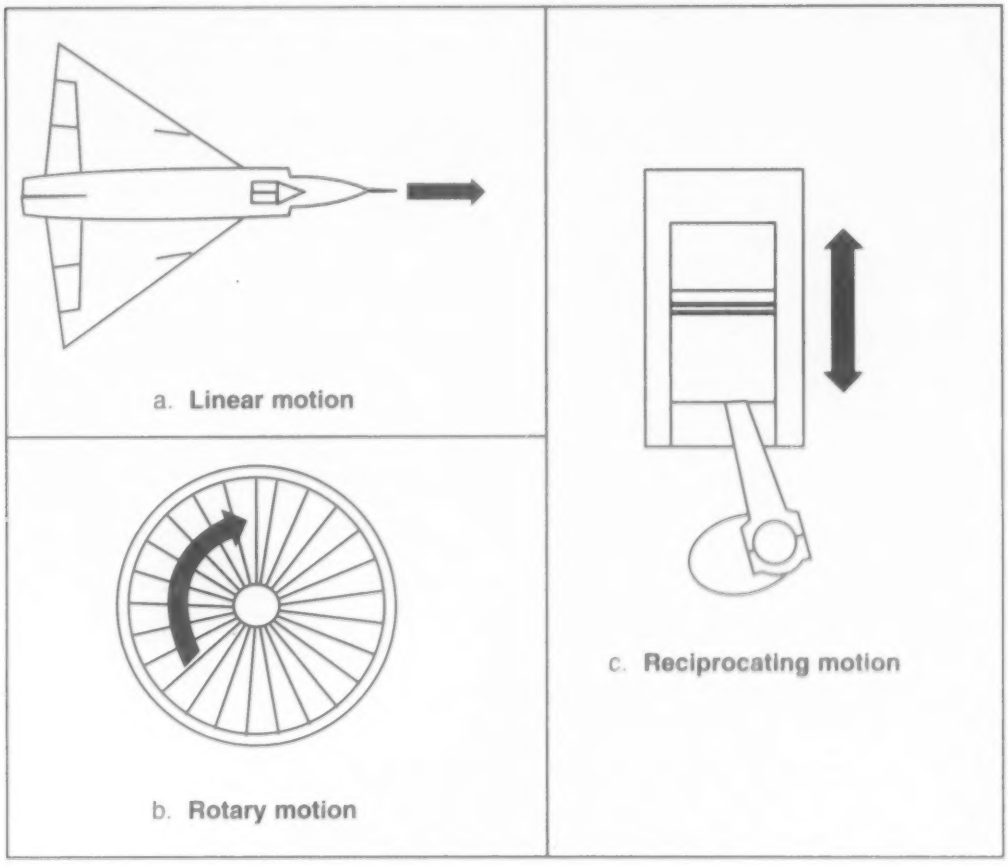
10. **Types of motion and their definitions**

    Note: All motion can be described as one of three types, or as a combination of two or all three types.

    - **Linear**—Motion along a straight line (see Figure 9-a on the next page)
    - **Rotary**—Motion along a circle (see Figure 9-b)
    - **Reciprocating**—Motion that follows a repeated pattern (see Figure 9-c)

      Note: *Reciprocating* means "mutually returning." An example of a reciprocating motion is the up-and-down motion of a piston in a gas-powered internal-combustion engine (see Figure 9-c).

Figure 9: Types of motion



11. Characteristics of motion

Note: In Objective 1, you learned that a *force* is an agent that causes a change in the direction or speed of an object in motion, and that *momentum* is a combination of velocity and the mass (weight) of an object; the faster an object travels or the more weight it has, the greater its momentum.

- **An object in motion will continue in motion and an object at rest will stay at rest unless acted upon by another force.**

  Note: The statement above is called the *law of inertia. Inertia* is the tendency of an object in motion to continue in motion or of an object at rest to stay at rest. Numerous forces can act upon an object that is at rest or in motion. One of those forces is *gravity* (the attraction the earth has for objects). Gravity is the reason an object will drop to the ground if you release it, rather than remaining in place as it should by the law of inertia.

Information Sheet

- **A force can change the velocity of an object if the force is greater than the momentum of the object.**

  Note: A force can be immediately greater than the momentum of an object and, therefore, change the velocity of the object immediately. For example, when you run into a brick wall, your velocity changes immediately. Or, a force can gradually change the velocity of an object, such as the gradual pull of gravity that makes a bullet hit the ground eventually even if the bullet was fired up or parallel to the ground.

- **For every action, there is an equal and opposite reaction.**

  Note: The statement above is called the *law of motion*, and it explains, for example, why a balloon moves in one direction as air is expelled from it in the opposite direction.

12. **Types of power systems used to control and transmit power**

    - **Mechanical power system**

      Note: A mechanical power system uses devices such as gears, pulleys, chains, and brakes to control and transmit mechanical energy.

    - **Electrical power system**

      Note: An electrical power system uses devices such as switches, relays, transformers, conductors, transmitters, insulators, solenoids, and motors to control and transmit electrical energy.

    - **Fluid power system**

      Note: A fluid power system uses either a liquid or a gas under pressure to transmit and control fluid energy. There are two kinds of fluid power systems: hydraulic (where the fluid under pressure in the system is usually water or oil) and pneumatic (where the gas under pressure in the system is usually air).

    - **Thermal power system**

      Note: A thermal power system uses devices such as conductors and insulators to control and transmit thermal energy.

13. **Definition of the term *transportation***

    - **Transportation**—The movement of people and things

14. **The goal of transportation technology**—To move people and things greater distances at greater speeds with less expenditure of energy

Information Sheet

15. Types of transportation systems and their definitions

- **Stationary system**—System in which a vehicle remains in one place while moving people/things within the system

  Examples of vehicles used in stationary systems: Pipelines, escalators, moving sidewalks, elevators, conveyors

- **Land system**—System that moves people/things in vehicles that travel on land

  Examples: Highway transportation system (motorcycles, cars, buses, trucks); railway transportation system

- **Water system**—System that moves people/things in vessels that travel through water

  Note: Ships, barges, and tugboats are some of the vessels used in water transportation systems.

- **Air system**—System that moves people/things in vehicles that travel through the air

  Note: Air-transportation system vehicles can include lighter-than-air craft such as hot-air balloons, dirigibles, and blimps and heavier-than-air craft such as airplanes, jet planes, gliders, and helicopters.

- **Space system**—System that moves people/things in vehicles that travel into outer space

  Note: Space shuttles and rockets are some of the vehicles used in space transportation systems.

- **Intermodal system**—System that uses more than one of the above types of transportation systems to move people/things

Exploring Energy, Power, and Transportation Technology

Assignment Sheet 1—Research a Career in Energy, Power, and Transportation

Name _____ Date _____

Evaluation criteria	Rating
Directions have been followed.	_____
Research is thorough and accurate.	_____
Report is in correct format.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____

Introduction

In *Introduction to Technology Education*, Unit 5, "Career-Exploration Process," you learned the process for conducting career research. In this assignment sheet, you will use the skills you learned in Unit 5 to conduct career research in the area of energy, power, and transportation.

Exercise

Activity checklist

Put a checkmark on the blank line before each activity below as you complete it.

_____ 1. Four career areas and **some** of the specific occupations in the area of energy, power, and transportation are given in the list below and on the next page. Use this list as a beginning point in your career-exploration research process. There are many, many more careers in this area. You may be able to name other careers/occupations in this area, also.

Select one career you think you would like to explore, and **research that career**. Use the career-exploration process you learned in Unit 5 of *Introduction to Technology Education* in conducting your research.

Career areas in energy, power, and transportation

- Generation of electricity

  Engineer
  Plant supervisor
  Technician

Assignment Sheet 1

Careers (cont.)

- Energy exploration and research

  Engineer
  Geologist
  Chemist
  Surveyor
  Cartographer (map maker)

- Transportation

  Air-traffic controller
  Truck dispatcher
  Airplane pilot
  Railroad engineer
  Flight engineer
  Truck driver

- Conservation and environmental protection

  Environmental-control specialist
  Conservation specialist
  Chemist
  Scientist

_____ 2. **Compile the results** of your research, and prepare a **written research paper** to present the information you have compiled. A written research paper should include the following components:

- Title page
- Table of contents
- Introduction
- Body
- Conclusion
- Endnotes/footnotes

_____ 3. **Turn in your research paper** to your instructor for evaluation.

_____ 4. Your instructor will return your research paper with suggestions for improvement. Make the improvements your instructor suggests, and then, **return your research paper for final evaluation**.

Exploring Energy, Power, and Transportation Technology

Assignment Sheet 2—Analyze a Transportation System in Your Local Area

Name _____ Date _____

Evaluation criteria	Rating
Directions have been followed.	_____
Writing clearly describes the system used to transport the selected item to the local area.	_____
Drawing is neat, complete, and accurate and clearly illustrates the transportation system.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____

ASSIGNMENT SHEET 2

Introduction

In Objective 13 of the information sheet, you learned that *transportation* is defined as the movement of people and things, and in Objective 15, you learned the types of transportation systems. In this assignment sheet, you will study which types of transportation systems are used to transport the people and things that are brought into your local area.

Exercise

Activity checklist

Put a checkmark on the blank line before each activity below as you complete it.

_____ 1. Read Student Supplement 1, "Components of Transportation Systems," which begins on page 21.

_____ 2. As you have learned, transportation involves moving people and things. Nine items that are commonly transported into any area are listed on the next page.

Select one of the items from the list to study, and **research the type(s) of transportation systems** used to transport this item to your local area.

List the item of your choice on a piece of paper and have your instructor approve the item you have selected to study.

Assignment Sheet 2

Items transported to your local area

- Dairy products (milk, cheese, etc.)
- Produce (lettuce, apples, etc.)
- Clothing (shirts, coats, shoes, etc.)
- Construction materials (lumber, bricks, gravel, etc.)
- Printed materials (newspapers, books, magazines, etc.)
- Mail (U.S., UPS, express mail services, etc.)
- Raw materials for local industries
- Gasoline
- Tourists or visitors

_____ 3. **Write a description** of the stages in the transportation system used to transport the item of your choice to your local area and **draw a rough sketch** that illustrates the stages in your description.

Check with your instructor to determine whether he or she wants you to complete your description and sketch manually or use a computer and appropriate software.

_____ 4. **Turn in your description and your rough sketch** to your instructor for evaluation.

_____ 5. Your instructor will return your description and your sketch with suggestions for improvement. **Make the improvements your instructor suggests**, and then, **complete a final draft of your description and drawing**.

_____ 6. Return your final draft to your instructor for **final evaluation**.

Exploring Energy, Power, and Transportation Technology

Student Supplement 1—Components of Transportation Systems

Introduction

Driving the family car to and from the supermarket, sailing a boat for pleasure, transporting cargo in ships or by UPS, transporting people on buses—all of these activities are associated with different forms of transportation in different types of transportation systems. But, these activities are so common to us that we seldom do analysis to see just what makes transportation work. In this student supplement, you will learn to analyze a transportation system by

- studying the purposes of transportation systems,
- learning the components of a transportation system and their purposes within the transportation system,
- reviewing the types of transportation systems and their definitions, and
- studying facts about each of the types of transportation systems.

Purposes of transportation systems

- **For personal benefit**

  Examples: Driving the family car to and from the supermarket, sailing for pleasure, bicycling for exercise

- **For commercial** (monetary) **gain**

  Examples: Trucking companies, taxi companies, cargo ships, UPS, air-express companies, airlines

- **For government service or defense**

  Examples: City mass-transit buses, city garbage trucks, U.S. Postal Service, U.S. Naval ships, U.S. Air Force planes

Components of a transportation system and their purposes

- **Vehicle**—Carries the people/things
- **Control system**—Keeps the vehicle traveling at the proper speed and direction

  Examples: Steering wheel, rudder, brake

- **Power plant**—Moves the vehicle
- **Mode** (or medium)—Pathway that suspends or guides the vehicle

Student Supplement 1

Types of transportation systems and their definitions

- **Stationary system**—System in which a vehicle remains in one place while moving people/things within the system

  Examples: Pipeline transportation system; on-site transportation such as elevators, moving sidewalks, escalators, and conveyors

- **Land system**—System that moves people/things in vehicles that travel on land

  Examples: Highway transportation system; railroad transportation system

- **Water system**—System that moves people/things in vessels that travel through water

- **Air system**—System that moves people/things in vehicles that travel through air

- **Space system**—System that moves people/things in vehicles that travel into outer space

- **Intermodal system**—System that uses more than one of the above types of transportation systems to transport people/things

Facts concerning stationary systems

Pipeline transportation system

- Pipelines move many types of materials through metal or plastic pipes that may be located above or below ground.

- Materials commonly transported through pipelines include oil, water, natural gas, minerals (that are usually mixed with water to form what is called a *slurry*), and waste materials.

On-site transportation system

- On-site transportation systems include two basic types of systems: (1) systems that use vehicles such as elevators, escalators, and moving sidewalks that are primarily designed to move people within a building and (2) systems that use vehicles such as conveyors, cranes, hoists, industrial trucks, and fork lifts that are primarily designed to move materials within a building.

- Technological advances being developed in stationary transportation systems include computerized control of the speed and distribution of the products traveling through pipelines and conveyors and computerized monitoring of the load requirements in elevators and escalators.

Student Supplement 1

Facts concerning land systems

Highway transportation system

- A highway transportation system is a system in which people/things are moved through a network of roads and highways. Highways and roads form a local, state, and interstate network that connects all areas of the nation.
- Road signs, symbols, and maps help to direct traffic and communicate information about highway routes.
- Highways are used for personal, commercial, and government transportation. Commercial passenger service includes taxi and limousine service, local and regional bus lines, and large inter-city bus lines. Commercial freight service includes trucks and large tractor-trailers, such as tankers, refrigerated vans, and flatbed trailers.
- Vehicles used in a highway transportation system include bicycles, motorcycles, cars, buses, and trucks. These vehicles are independently controlled on the road or highway by a driver.
- Technological advances being developed for highway transportation systems include new sources of power for the vehicles used in this type of system and computerization of many components of the system.
  - — New power sources being developed and studied to power vehicles include methanol, synthetic fuels, hydrogen, and electrical batteries.
  - — Computerization of the components of a highway transportation system includes computerization of vehicle ignition and control systems, computerization of diagnostic and test equipment used to monitor vehicles, computerization of traffic-control equipment, and computerization of all forms of record-keeping associated with a highway transportation system.

Railway transportation system

- A railway transportation system moves people/things in vehicles that run on rails.
- The basic types of vehicles used in railway transportation are locomotives and rail cars (boxcars, flatcars, hoppers, etc.)
- The rails that the vehicles run on within a system may be located above ground (as for monorails and elevated railways), at ground level (as for a standard railway), or below ground (as for subways).
- A basic railway transportation system also includes
  - — stations for loading and unloading people,
  - — freight terminals for loading and unloading freight,

- — classification yards that are complexes of tracks for joining railroad cars or for breaking up and regrouping cars to make more efficient use of the railways,
- — control centers for monitoring the switching of trains and cars by dispatchers, and
- — engine/car shops for performing the major repairs and maintenance work on the vehicles involved in the system.

- Technological advances being studied in railway transportation include
  - — the Maglev train, a magnetically levitated train that can reach speeds of over 300 miles per hour and provide a quiet, smooth ride,
  - — computerized customer billing,
  - — computerized reservations on passenger trains, and
  - — computerized switching operations and car tracking.

Facts concerning water systems

- Bodies of water that are a part of a water transportation system include lakes, rivers, and oceans.
- The basic types of vessels that travel over these bodies of water include
  - — boats, which are small watercraft propelled by oars, sails, or engines,
  - — ships, which are larger watercraft propelled by engines for commercial transportation of people/things,
  - — barges, which are flat, commercial cargo vessels that are pushed or pulled by engine-driven vessels, usually tugboats or towboats, and
  - — specialized craft, such as a hydrofoil (a craft supported on wings called *foils* that create lift for the boat by deflecting water over the foil surfaces) and hovercraft (a craft that relies on a cushion of air between the hull or body and the surfaces—land or water—over which it operates).
- The components of a water transportation system are used to meet personal, commercial, and governmental transportation needs.
  - — Personal transportation includes the use of boats and ships for travel and recreation.
  - — Commercial transportation includes the ocean liners that transport people on cruises, cargo liners or freighters that operate on regular sailing schedules to transport cargo, and tramps that transport cargo but do not operate on fixed sailing schedules.

Student Supplement 1

— Government transportation includes the many vessels used by the military for national defense and service. These vessels include battleships, aircraft carriers, submarines, and patrol boats.

Facts concerning air systems

- The basic types of vehicles used in air transportation systems include lighter-than-air craft and heavier-than-air craft.
  - — Lighter-than-air craft include hot-air balloons, dirigibles, and blimps.
  - — Heavier-than-air craft include airplanes, gliders, and helicopters.
  - — Airplanes include props (airplanes powered by propeller-driven engines) and jets (airplanes powered by jet engines).
- The vehicles used in air transportation systems must be supported by airports, where personnel monitor flights, help passengers board, and load cargo.
- Air transportation systems are used to meet personal, commercial, and government transportation needs.
  - — Personal air-transportation needs are usually met by small planes that can carry only a few people/things.
  - — Commercial air-transportation needs are usually met with large commercial aircraft that may carry passengers, mail, or other cargo.
  - — Military air-transportation needs are usually met with planes designed for specific military use, such as fighter planes, bombers, and cargo planes.
- Technological advances being studied in air transportation include
  - — propfan-design propeller-driven engines, which have from 8 to 10 propeller blades that are shorter and turn faster than the propeller blades used on common propeller-driven engines, and are being studied because they will use 20 percent less fuel, and
  - — canard-design aircraft, which place the wings at or near the end of the aircraft, and are being developed to create a light, fast, fuel-efficient, and safe aircraft, and
  - — computerization, which is being developed in the areas of airplane design, airplane gauges and controls, air-traffic controls, and airline reservations.

Facts concerning space systems

- Space transportation is used primarily by the government for conducting experiments in space and for exploring space, although space vehicles are sometimes hired by commercial firms to place objects such as weather/communication satellites in orbit and to conduct other scientific experiments.

STUDENT SUPPLEMENT 1

Student Supplement 1

- Vehicles used in space transportation systems are classified as being either manned or unmanned. The satellites used for communication, weather forecasting, and military reconnaissance are examples of unmanned vehicles. The space shuttles and the space lab are examples of manned vehicles.

- Almost every technology being used in space transportation could be classified as being "new"; however, some of the technologies presently being explored involve

  — space-vehicle fuel cells that will produce electricity from a chemical reaction between hydrogen and oxygen, and

  — new extremely light but strong composite materials made from a resin-coated, paper-like polymer covered with graphite fibers imbedded in epoxy.

Exploring Energy, Power, and Transportation Technology

Lab Activity Sheet 1—Create and Test a Simple Device for Storing Energy

Introduction

Electrical cells, or *batteries*, are among the most common devices used for storing energy. In fact, when the eighteenth-century Italian scientist Alessandro Volta invented the electrical battery, it became the first electrical storage device and the first source of continuous electrical current. In this lab activity sheet, you will create a simple device for storing energy and learn something more about electrical current.

Equipment and materials

Your instructor will provide you with the following materials:

- Galvanometer (an instrument for detecting or measuring a small electric current), a hook-up wire, and instructions for the galvanometer's use
- Lemon
- Penny
- Dime
- Knife
- Metric measuring device
- Fine abrasive paper

Procedure

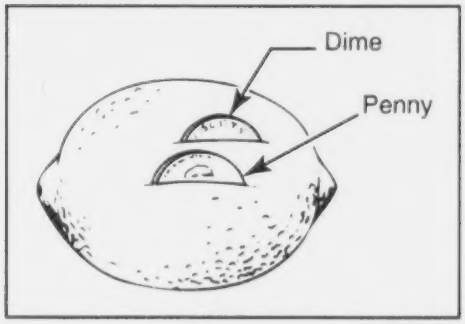
Put a checkmark on the blank line before each step below as you complete it.

_____ 1. Review the worksheet associated with this lab activity, which begins on page 29.

_____ 2. Create the storage device:

- With the knife, make two small slits in the lemon; the slits should each be 1cm long and 1cm deep, and the slits should be 2cm apart.
- Use the abrasive paper to clean thoroughly both sides of the penny and the dime.
- Insert a coin into each slit in the lemon; each coin should stick out a bit from the surface of the lemon (see Figure 1).

Figure 1: Coins inserted in the lemon



_____ 3. Complete the pre-performance check for the procedure (Part A) on the worksheet and receive your instructor's signed approval for the information you have listed for performing the procedure.

_____ 4. Review the evaluation criteria listed in the performance evaluation (Part C) on the worksheet.

_____ 5. Test the storage device:

- Attach one lead of the galvanometer to the dime.
- Read the meter and record the reading in the blank provided for "Galvanometer reading 1" in Part B on the worksheet.
- Attach the other galvanometer lead to the penny.
- Read the meter and record the reading in the blank provided for "Galvanometer reading 2" in Part B on the worksheet.

_____ 6. Complete the question in Part B on the worksheet.

_____ 7. Turn in your completed worksheet to your instructor for evaluation.

_____ 8. Your instructor will rate your performance using the evaluation criteria listed in Part C on the worksheet.

Lab Activity Sheet 1

Worksheet—Create and Test a Simple Device for Storing Energy

Name _____ Attempt number _____

Date _____

Part A: Pre-performance check

Your instructor's signature below, indicates that you have correctly created the storage device and are ready to perform the galvanometer test.

If your storage device requires improvements and corrections, your instructor will indicate those in the space below.

Instructor's signature _____

Lab Activity Sheet 1

Worksheet—Create and Test a Simple Device for Storing Energy

Part B: Test readings and evaluation

- Complete the blanks below to record the galvanometer readings you take to test the storage device.

  Galvanometer reading 1 _____

  Galvanometer reading 2 _____

- Answer the question below in the space provided below the question.

  From the galvanometer readings you have taken in the test procedure, what type of energy is being stored in this simple device? Explain why you think so.

Lab Activity Sheet 1

Worksheet—Create and Test a Simple Device for Storing Energy

Part C: Performance evaluation

Evaluation criteria	**Rating**
Procedure was completed correctly and accurately.	_____
Worksheet was completed correctly and accurately.	_____
Clean-up and follow-up actions were adequate.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____

Exploring Energy, Power, and Transportation Technology

Lab Activity Sheet 2—Construct and Evaluate the Effectiveness of Two Simple Solar Collectors

Introduction

As you learned in Objective 4 of the information sheet, solar energy is an inexhaustible source of energy. In this lab activity, you will construct two solar-energy collectors and evaluate the effectiveness of each collector's ability to convert solar energy into heat (thermal energy).

Equipment and materials

Your instructor will provide you with the following materials:

- Two 2-pound coffee cans
- Two 1-pound coffee cans
- Two small thermometers
- Can of black spray paint
- Newspaper
- Clear-plastic refrigerator wrap
- Rubber bands
- Removable tape
- Marking pen

Procedure

Put a checkmark on the blank line before each step below as you complete it.

_____ 1. Review the worksheet associated with this lab activity, which begins on page 35.

_____ 2. Create the solar collectors:

- Spray-paint the inside of one of the 1-pound coffee cans with the black paint and allow the paint to dry.
- Use the removable tape to tape one of the small thermometers to the inside wall of each of the 1-pound coffee cans. Place each thermometer at the same height/location on each coffee can.

  Note: Do **not** tape the thermometers to the bottoms of the coffee cans.

- Center a 1-pound coffee can into each 2-pound coffee can, and then, secure the 1-pound coffee cans in place with the removable tape.
- Use the marking pen to label as "Collector 1" the outside of the 2-pound coffee can with the 1-pound coffee can that was painted black.
- Use the newspaper to line the space between the two coffee cans in Collector 1.
- Use the marking pen to label as "Collector 2" the outside of the other 2-pound coffee can.

Lab Activity Sheet 2

- Cover the opening of each 2-pound coffee can with the clear-plastic refrigerator wrap; secure the plastic wrap with a rubber band.

- Select a position for the solar collectors that will meet the specification below:

  The collectors must be placed outdoors in an area that will receive direct sunlight for a 30-minute period.

_____ 3. Complete the pre-performance check for the procedure (Part A) on the worksheet and receive your instructor's signed approval for the information you have listed for performing the procedure.

_____ 4. Review the evaluation criteria listed in the performance evaluation (Part C) on the worksheet.

_____ 5. Test the solar collectors:

- Place your collectors on the selected site and position each collector so that as little sunlight as possible hits the thermometers directly.

- Take readings from the thermometers in the coffee cans once every 5 minutes for a 30-minute period; record your readings on the chart in Part B on the worksheet.

_____ 6. Complete the evaluation questions in Part B on the worksheet.

_____ 7. Turn in your completed worksheet to your instructor for evaluation.

_____ 8. Your instructor will rate your performance using the evaluation criteria listed in Part C on the worksheet.

Lab Activity Sheet 2

Worksheet—Construct and Evaluate the Effectiveness of Two Simple Solar Collectors

Name _____ Attempt number _____

Date _____

Part A: Pre-performance check

Complete the following information concerning the construction of your solar collectors and the site you have selected for your evaluation test.

- Select a site that you believe would be a good location for conducting your evaluation test. In the space below, describe that site.

- Have your instructor evaluate the construction of your solar collectors and the site you have described above. Your instructor's signature below, indicates that you have correctly constructed the solar collectors and are ready to perform the evaluation test.

  If your solar collectors require improvements and corrections or the site you have described needs to be changed, your instructor will indicate those improvements/ changes in the space below.

Instructor's signature _____

Lab Activity Sheet 2

Worksheet—Construct and Evaluate the Effectiveness of Two Simple Solar Collectors

Part B: Test records and evaluation

- Complete the chart below to record the readings you take during the evaluation test.

Time	Thermometer reading	
	Collector 1	Collector 2
0 min.		
5 min.		
10 min.		
15 min.		
20 min.		
25 min.		
30 min.		

- Answer the questions below.

1. What reasons can you give for the differences in the thermometer readings of the solar collectors during the test period? List your reasons on a separate sheet(s) of paper.

2. Brainstorm ways that you might be able to use the energy from your most-effective solar collector or from a group of similar solar collectors. List and explain five of your ideas on a separate sheet(s) of paper.

Lab Activity Sheet 2

Worksheet—Construct and Evaluate the Effectiveness of Two Simple Solar Collectors

Part C: Performance evaluation

Evaluation criteria	**Rating**
Procedure was completed correctly and accurately.	_____
Worksheet was completed correctly and accurately.	_____
Clean-up and follow-up actions were adequate.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____

Exploring Energy, Power, and Transportation Technology

Lab Activity Sheet 3—Construct and Analyze the Operation of an Energy-Conversion Simulator

Introduction

In Objective 7 of the information sheet you learned that energy cannot be created or destroyed; energy can only be converted from one type to another. In Objective 9, you studied the types of energy conversions. In this lab activity, you will construct a conversion simulator that will enable you to analyze several different energy conversions, and by doing so, better understand the information you studied in Objectives 7 and 9.

Equipment and materials

Your instructor will provide you with the following materials:

- Electric motor mounted on a wood-block base
- Turbine component
- 1.5-volt LED (light-emitting diode)
- Two wires to use for leads
- Hot-plate burner
- Metal pan
- Beaker
- Beaker stopper with rubber tubing

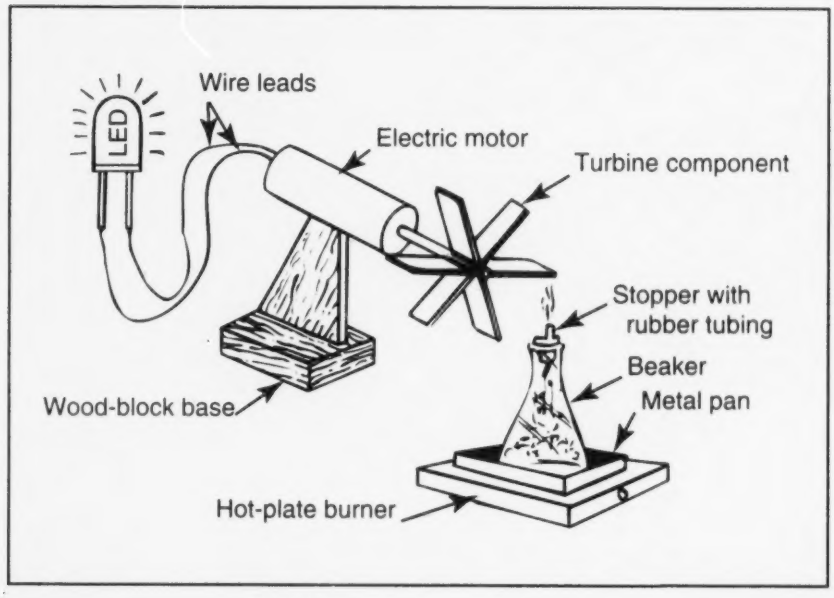
Procedure

Put a checkmark on the blank line before each step below as you complete it.

_____ 1. Review the worksheet associated with this lab activity, which begins on page 41.

_____ 2. Study the sketch of the completed conversion-simulator setup in Figure 1 below.

Figure 1: Conversion-simulator setup



Lab Activity Sheet 3

_____ 3. Set up the components of the conversion simulator:

- Attach the wire leads to the electric motor and the LED.
- Place the metal pan on the hot-plate burner.
- Fill the beaker with water and place the beaker in the metal pan on the hot-plate burner.
- Place the beaker stopper with the rubber tubing in the beaker to seal the beaker.
- Position the hot plate so that the rubber tubing in the beaker stopper is under the blades of the turbine component.

_____ 4. Complete the pre-performance check for the procedure (Part A) on the worksheet and receive your instructor's signed approval for the information you have listed for performing the procedure.

_____ 5. Review the evaluation criteria listed in the performance evaluation (Part C) on the worksheet.

_____ 6. Turn the hot-plate burner on, and as the water in the beaker boils, observe the conversion processes taking place.

_____ 7. Complete the process analysis in Part B on the worksheet.

_____ 8. Turn in your completed worksheet to your instructor for evaluation.

_____ 9. Your instructor will rate your performance using the evaluation criteria listed in Part C on the worksheet.

Lab Activity Sheet 3

Worksheet—Construct and Analyze the Operation of an Energy-Conversion Simulator

Name _____ Attempt number _____

Date _____

Part A: Pre-performance check

Complete the following information concerning the construction of your conversion simulator.

- Have your instructor evaluate the conversion-simulator setup. Your instructor's signature below indicates that you have correctly set up the components of the simulator and are ready to perform the process analysis.

  If your conversion-simulator setup requires improvements and corrections, your instructor will indicate those improvements/corrections in the space below.

Instructor's signature _____

Lab Activity Sheet 3

Worksheet—Construct and Analyze the Operation of an Energy-Conversion Simulator

Part B: Process analysis

After the water in the beaker boils, you should be able to observe several energy conversions taking place. Each of the phrases below describes an energy conversion. Beside each phrase, state the components in the conversion-simulator setup where you think that particular energy conversion is taking place.

- Electrical energy to heat (thermal energy)

- Thermal energy to steam

- Steam to mechanical energy

- Mechanical energy to electrical energy

- Electrical energy to light

Lab Activity Sheet 3

Worksheet—Construct and Analyze the Operation of an Energy-Conversion Simulator

Part C: Performance evaluation

Evaluation criteria	**Rating**
Procedure was completed correctly and accurately.	_____
Worksheet was completed correctly and accurately.	_____
Clean-up and follow-up actions were adequate.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____

Exploring Energy, Power, and Transportation Technology

Lab Activity Sheet 4—Design, Construct, and Evaluate a Water-Powered Lifting/Lowering Device

Introduction

In Lab Activity Sheet 4 and Lab Activity Sheet 5, you will apply some of the information you have studied in the information sheet and some new information you will study in Student Supplement 2. Then, you will use your creative and logical thinking skills to design and then construct and evaluate an original invention to solve the problem set up in each lab activity.

In this lab activity, you will design, construct, and evaluate a water-powered device that will lift and lower an object.

Procedure

Put a checkmark on the blank line before each step below as you complete it.

_____ 1. Review the information in the following objectives in the information sheet:

- The definition of *hydro energy* as an inexhaustible source of energy in Objective 4.
- The *characteristics of energy* in Objective 7.
- The *statements concerning the conversion of energy to power and the transmission of power to do work* in Objective 8.
- The definition of *reciprocating motion* in Objective 10.
- The *characteristics of motion* in Objective 11.
- The definition of a *stationary transportation system* in Objective 15.

_____ 2. Study the information in Student Supplement 2, "Devices Used for Controlling and Transmitting Power in Mechanical Power Systems," which begins on page 51.

_____ 3. Your instructor will divide your class into groups of two, and you and your partner will study the rules and regulations for this activity, which are presented below and on the next page.

Rules and regulations

- All of the materials you select to use to construct your lifting/lowering device must be readily available in your technology-education classroom.
- Your lifting/lowering device must be powered only by the energy resulting from the movement of water.

Lab Activity Sheet 4

- You may incorporate in your design only the devices mentioned in Student Supplement 2.
- Your water-powered device may use no more than 1 quart of water in its design.
- The object to be lifted/lowered by your water-powered device must weigh at least 1 pound.
- Your water-powered device must be able to lift the object 2 vertical feet in less than 20 seconds.
- Your water-powered device must be able to lower the object to its original position in less than 10 seconds.
- Penalty points will be deducted from your rating if the object is not lifted in less than 20 seconds and lowered in less than 10 seconds.

_____ 4. Review the worksheet associated with this lab activity, which begins on page 47.

_____ 5. Complete the pre-performance check for the procedure (Part A) on the worksheet and receive your instructor's signed approval for the information you have written and the equipment/materials you have listed for performing the procedure.

_____ 6. Review the evaluation criteria listed in the performance evaluation (Part D) on the worksheet.

_____ 7. Using the instructor-approved information and equipment/materials list on the worksheet, construct the water-powered device.

_____ 8. Test-run the water-powered device three times, fill in the chart in Part B on the worksheet after each test, and then, complete the evaluation item also in Part B. Receive your instructor's signed approval for the information you have written.

_____ 9. Using the instructor-approved information you have written in Part B on the worksheet, make the modification to your water-powered device, and then, retest the water-powered device once, fill in the chart in Part C on the worksheet after the retest, and then, complete the evaluation items also in Part C.

_____ 10. Your instructor will rate your performance using the evaluation criteria listed in Part D on the worksheet.

Lab Activity Sheet 4

Worksheet—Design, Construct, and Evaluate a Water-Powered Lifting/Lowering Device

Name _____ Attempt number _____

Date _____

Part A: Pre-performance check

Complete the following information concerning the design of the water-powered device.

- On a separate sheet(s) of paper, draw a design of the water-powered lifting/lowering device you will construct and write a description of how you believe the device will function. Check with your instructor to see whether your design/description should be completed manually or on a computer, using appropriate software.
- In the space below (or on a separate sheet of paper), list the equipment/materials required to construct the water-powered lifting/lowering device you have designed.

Instructor's signature _____

Lab Activity Sheet 4

Worksheet—Design, Construct, and Evaluate a Water-Powered Lifting/Lowering Device

Part B: Test evaluation

- Complete the chart below to record the lifting/lowering times of your water-powered device after each of the three "test runs" you make of the device.

Lifting time	Lowering time
Test 1 _____	Test 1 _____
Test 2 _____	Test 2 _____
Test 3 _____	Test 3 _____

- Answer the item below.

  Brainstorm ways that you might improve the performance of your water-powered lifting/lowering device without altering its basic design. Select one of your ideas to plan a modification to your original design. Explain your idea for a modification on a separate sheet(s) of paper.

Instructor's signature _____

Lab Activity Sheet 4

Worksheet—Design, Construct, and Evaluate a Water-Powered Lifting/Lowering Device

Part C: Retest evaluation

- On the blank lines provided below, record the lifting/lowering times of your water-powered device during the retest of your modified design.

  Lifting time _____

  Lowering time _____

- Answer the items below.

  1. How did the design modification affect your water-powered device's lifting/lowering performance? (Did your modification improve the performance of your device?) Explain why you believe your device's performance was affected by the modification.

  2. Do you think your water-powered device would be a viable alternative to a lifting/lowering device powered by fossil fuels? Explain.

Lab Activity Sheet 4

Worksheet—Design, Construct, and Evaluate a Water-Powered Lifting/Lowering Device

Part D: Performance evaluation

Evaluation criteria	**Rating**
Design of the device meets the rules and regulations set for the procedure.	_____
Design of the device is creative and unique.	_____
Presentation of the design drawing and description of the device is neat, accurate, and well organized visually.	_____
During the test, the device functions according to the rules and regulations set in the procedure.	_____
Note to the evaluator: Penalty points must be deducted if the device does not lift the object in less than 20 seconds and lower the object in less than 10 seconds.	
Lab clean-up and follow-up actions were satisfactory.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____

Exploring Energy, Power, and Transportation Technology

Student Supplement 2—Devices Used for Controlling and Transmitting Power in Mechanical Power Systems

Introduction

As you learned in Objective 1 in the information sheet, *power* is the rate at which energy is transmitted; it is a measure of the movement of energy. Because the movement of energy involves travel across distance, power is a measure of how much time it takes for the distance to be covered. The basic concept is that the greater the power, the less time required for the distance to be traveled.

In this supplement, you will study one of the types of power systems used to control and transmit power—mechanical power systems.

Some of the devices used to control and transmit mechanical energy in mechanical power systems are (1) simple machines; (2) mechanical drives; (3) shafts, couplings, and clutches; and (4) complex machines.

Simple machines

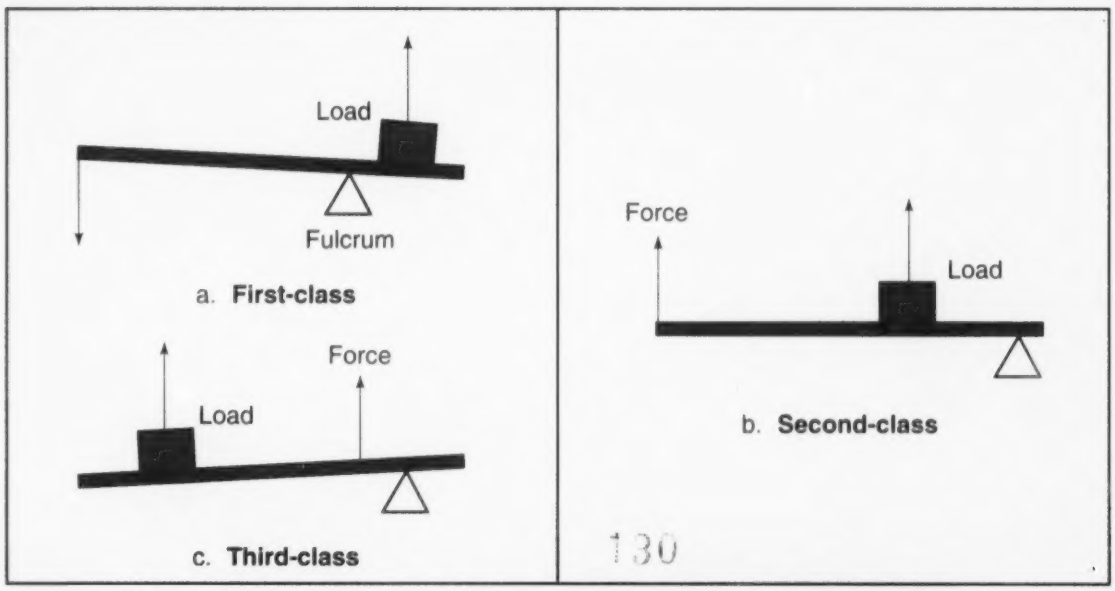
Simple machines are used in mechanical power systems to control and transmit linear and rotational mechanical energy. There are six types of simple machines: (1) levers, (2) wheels and axles, (3) pulleys, (4) inclined planes, (5) wedges, and (6) screws.

- **Lever**

  A *lever* consists of a bar and a fulcrum (see Figure 1). The bar rests on the fulcrum (pivot point) at some point along the bar.

  There are three types of levers: first-class levers, second-class levers, and third-class levers (see Figure 1). Examples of first-class levers are a teeter totter and a pry bar. An example of a second-class lever is a wheelbarrow. An example of a third-class lever is the human arm.

Figure 1: Types of levers



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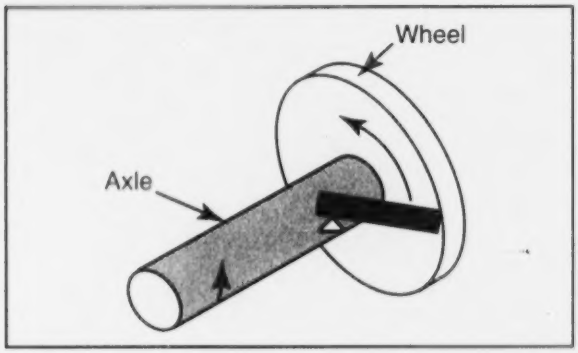
- **Wheel and axle**

A *wheel and axle* works on the same principle as a lever—the center of the axle is the fulcrum and the radius of the wheel acts as the lever (see Figure 2).

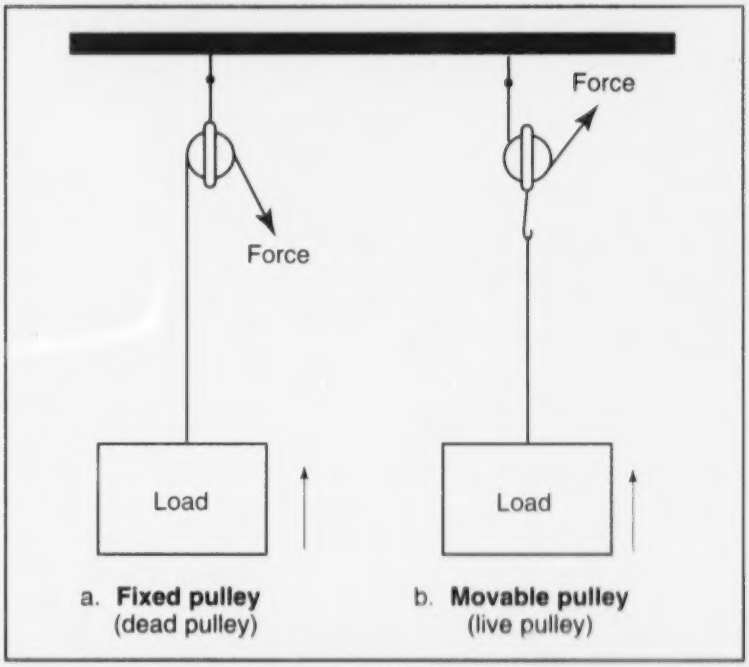
Figure 2: Principle of a lever



- **Pulley**

A *pulley* is a device used to change the direction of a pulling force or in various combinations to increase force for lifting weight (loads). There are two types of pulleys—fixed (dead) pulleys and movable (live) pulleys (see Figure 3).

Figure 3: Types of pulleys



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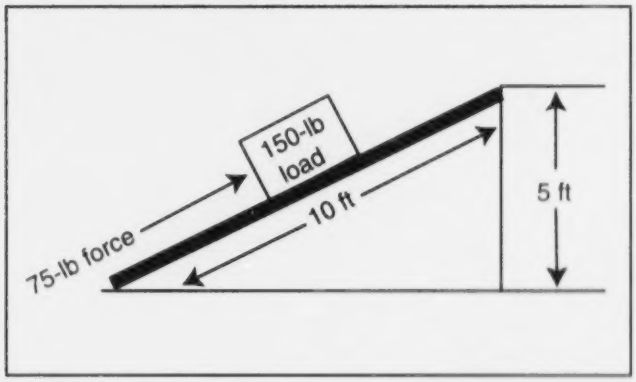
- **Inclined plane**

An *inclined plane* is a sloping surface. A sloping surface is used to increase force. *Force* is an agent that causes motion or causes a change in the direction or speed of an object in motion. For example, to directly lift the load shown in Figure 4 would have required 150 pounds of force, but, by using the inclined plane at the slope (grade) shown (10/5), only 75 pounds of force are required.

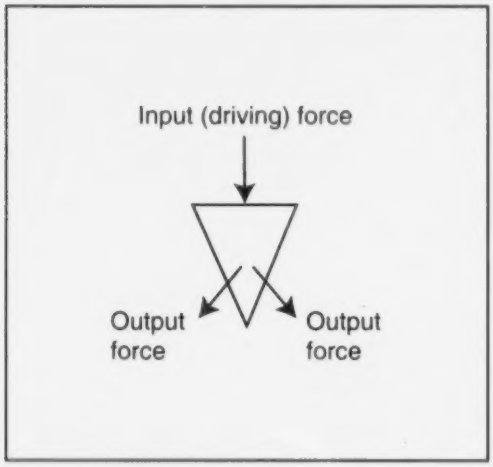
Figure 4: Using an inclined plane to increase force



- **Wedge**

A *wedge* is actually two inclined planes placed so that the sloping sides come together at a point. The wedge is also used to increase force. Figure 5 shows how the output force is greater than the input (driving) force through the use of a wedge.

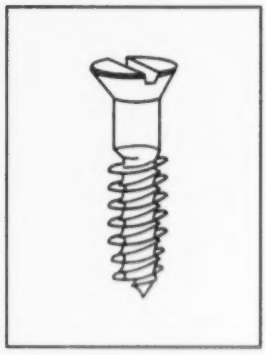
Figure 5: Using a wedge to increase force



- **Screw**

A *screw* is actually an inclined plane cut in a spiral around a cone or shaft (see Figure 6). Therefore, the screw is also used to increase force.

Figure 6



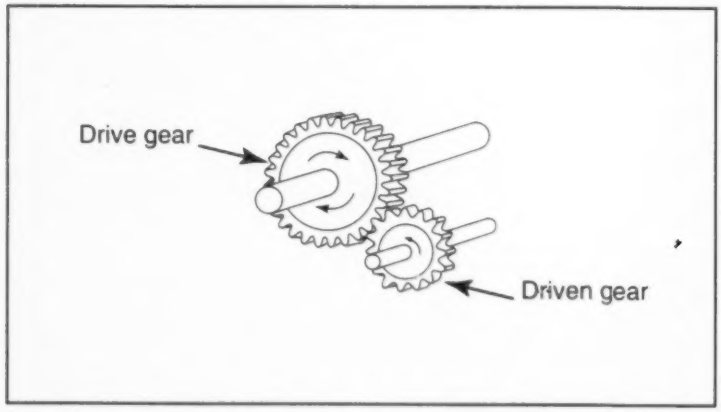
Mechanical drives

Mechanical drives are used in a mechanical power system to transmit and control rotational mechanical energy. There are three types of mechanical drives: (1) gear drives, (2) belt drives, and (3) chain drives.

- **Gear drive**

A *gear* is a wheel that has teeth around its outside surface. A *gear drive* consists of two gears with teeth that mesh and cause the wheels to turn in opposite directions (see Figure 7). In a gear drive, the gear connected to the power source is called the *drive gear*; the other gear is called the *driven gear*.

Figure 7



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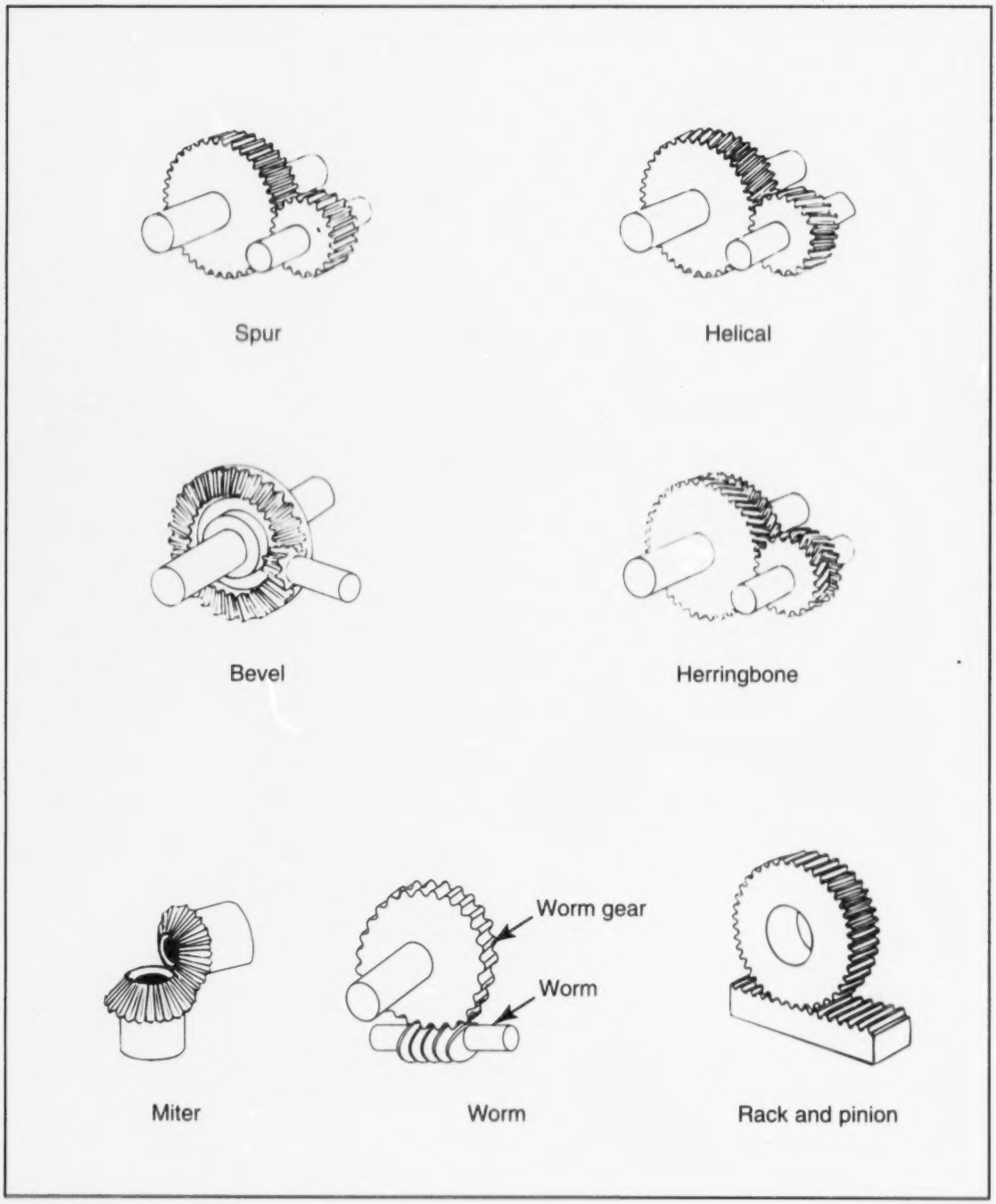
There are many types of gear drives, some of which are shown in Figure 8.

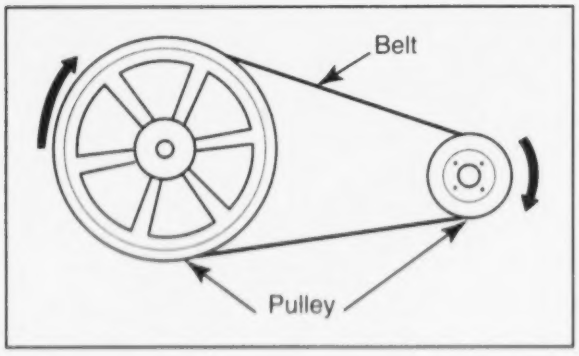
Figure 8: Types of gears



- **Belt drive**

A belt drive consists of two pulleys (usually grooved metal discs) that drive or are driven by a flexible belt (see Figure 9). In a belt drive, rotation in one pulley is transmitted to the other pulley through the belt, and both pulleys turn in the same direction.

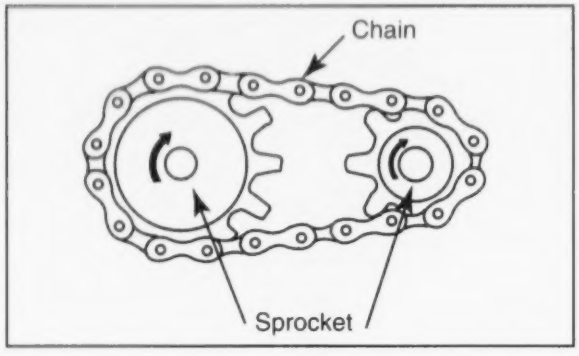
Figure 9



- **Chain drive**

A chain drive consists of two sprockets that drive or are driven by a chain. In a chain drive, both sprockets turn in the same direction (see Figure 10).

Figure 10



Shafts, couplings, and clutches

The devices listed in the two sections above are referred to as the *driving devices* in a mechanical power system. However, other types of devices are also used for specific purposes in this type of system. Three of these devices are (1) shafts, (2) couplings, and (3) clutches.

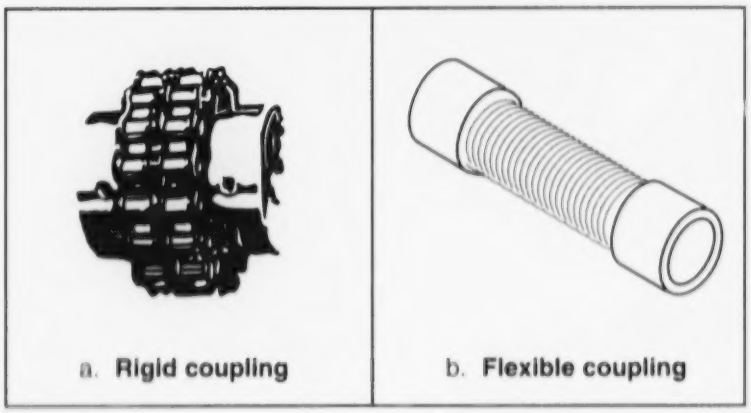
- **Shaft**

A *shaft* is a cylindrical bar used to support rotating pieces or to transmit power or motion by rotation.

- **Coupling**

A *coupling* is a permanent connection used to change the direction of or to connect lengths of shafts. Couplings may be either rigid or flexible (see Figure 11).

Figure 11: Types of couplings

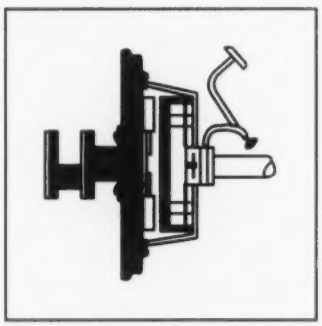


a. **Rigid coupling** b. **Flexible coupling**

- **Clutch**

A *clutch* is a device that connects or disconnects the flow of power from one component in a power system to another (see Figure 12). There are many different types of clutches. Two common types of clutches are friction clutches and centrifugal clutches.

Figure 12



Two complex machines

A *complex machine* is a machine that uses the principles of two or more simple machines singularly or in various combinations. In this supplement you will study two types of complex machines—waterwheels and windmills.

- **Waterwheel**

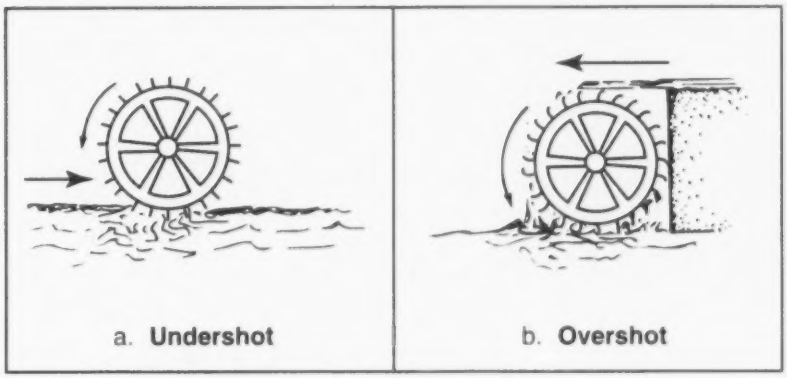
A *waterwheel* is a wheel that is made to rotate by the direct action of moving water. There are two types of waterwheels—undershot and overshot.

Student Supplement 2

With an *undershot* waterwheel, water moves under the wheel, and the movement of the water produces the power to rotate the wheel (see Figure 13-a).

With an *overshot* waterwheel, water moves over the top of the wheel, and both the weight of the water and the movement of the water produce the power to rotate the wheel (see Figure 13-b).

Figure 13: Types of waterwheels

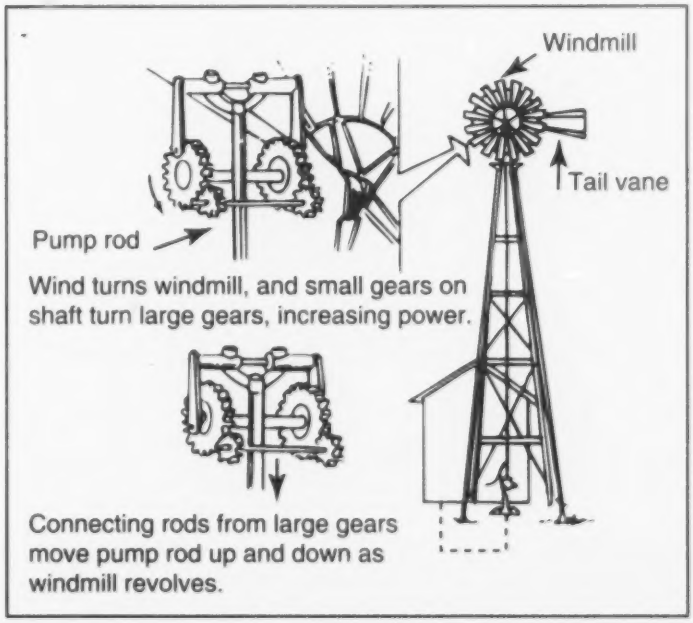


a. **Undershot** b. **Overshot**

- **Windmill**

A *windmill* is a wheel that is made to rotate by the direct action of wind. Figure 14 illustrates how a windmill is used to provide the power to pump water.

Figure 14


Windmill
Tail vane
Pump rod
Wind turns windmill, and small gears on shaft turn large gears, increasing power.
Connecting rods from large gears move pump rod up and down as windmill revolves.

Exploring Energy, Power, and Transportation Technology

Lab Activity Sheet 5—Design, Construct, and Evaluate a Wind-Powered Delivery Device

Introduction

In this lab activity—as you did in Lab Activity Sheet 4—you will apply some of the information you have studied in the information sheet and in Student Supplement 2. Then, you will use your creative and logical thinking skills to design and construct an original invention to solve the problem set up in the lab activity.

In this lab activity, you will create and construct a wind-powered device that will deliver an object to a destination in less than 10 seconds.

Procedure

Put a checkmark on the blank line before each step below as you complete it.

_____ 1. Review the information in the following objectives in the information sheet:

- The item on *wind energy* as an inexhaustible source of energy in Objective 4.
- The *characteristics of energy* in Objective 7.
- The *statements concerning the conversion of energy to power and the transmission of power to do work* in Objective 8.
- The definition of *linear motion* in Objective 10.
- The *characteristics of motion* in Objective 11.
- The definition of a *land transportation system* in Objective 15.

_____ 2. Study the information in Student Supplement 2, "Devices Used for Controlling and Transmitting Power in Mechanical Power Systems," which begins on page 51.

_____ 3. Your instructor will divide your class into groups of two, and you and your partner will study the rules and regulations for this activity, which are presented below and on the next page.

Rules and regulations

- All of the materials you select to use to construct your delivery device must be readily available in your technology-education classroom.
- Your delivery device must be powered by the energy from the movement of air. Your instructor will provide you with an electric fan to provide the moving air.

Lab Activity Sheet 5

- You may incorporate in your design only the devices mentioned in Student Supplement 2.
- The object to be delivered must weigh at least 4 ounces.
- Your wind-powered delivery device must be able to travel 20 linear feet in less than 10 seconds with the object to be delivered on board.

  The starting point and the destination point for your delivery system must be on the same horizontal plane.
- Penalty points will be deducted from your rating if the object is not delivered in less than 10 seconds.

_____ 4. Review the worksheet associated with this lab activity, which begins on page 61.

_____ 5. Complete the pre-performance check for the procedure (Part A) on the worksheet and receive your instructor's signed approval for the information you have written and the equipment/materials you have listed for performing the procedure.

_____ 6. Review the evaluation criteria listed in the performance evaluation (Part D) on the worksheet.

_____ 7. Using the instructor-approved information and equipment/materials list on the worksheet, construct the device.

_____ 8. Test-run the wind-powered device three times, fill in the chart in Part B on the worksheet after each test, and then, complete the evaluation item also in Part B. Receive your instructor's signed approval for the information you have written.

_____ 9. Make the modification to your wind-powered device, and then, retest the wind-powered device once; fill in the chart in Part C on the worksheet after the retest, and then, complete the evaluation items also in Part C.

_____ 10. Your instructor will rate your performance using the evaluation criteria listed in Part D on the worksheet.

Lab Activity Sheet 5

Worksheet—Design, Construct, and Evaluate a Wind-Powered Delivery Device

Name _____ Attempt number _____

Date _____

Part A: Pre-performance check

Complete the following information concerning the design of the wind-powered delivery device.

- On a separate sheet(s) of paper, draw a design of the wind-powered delivery device you will construct and write a description of how you believe the device will function.

  Check with your instructor to see whether your design/description should be completed manually or on a computer, using appropriate software.

- In the space below (or on a separate sheet of paper), list the equipment/materials required to construct the wind-powered delivery device you have designed.

Instructor's signature _____

Lab Activity Sheet 5

Worksheet—Design, Construct, and Evaluate a Wind-Powered Delivery Device

Part B: Test evaluation

- Complete the chart below to record the delivery times of your wind-powered device after each of the three "test runs" you make of the device.

  Delivery time

  Test 1 _____

  Test 2 _____

  Test 3 _____

- Answer the item below.

  Brainstorm ways that you might improve the performance of your wind-powered delivery device without altering its basic design. Select one of your ideas to plan a modification to your original design. Explain your idea for a modification on a separate sheet(s) of paper.

Instructor's signature _____

Lab Activity Sheet 5

Worksheet—Design, Construct, and Evaluate a Wind-Powered Delivery Device

Part C: Retest evaluation

- On the blank line provided below, record the delivery time of your wind-powered device during the retest of your modified design.

  Delivery time _____

- Answer the items below.

  1. How did the design modification affect your wind-powered device's delivery performance? (Did your modification improve the performance of your device?) Explain why you believe your device's performance was affected by the modification.

  2. Do you think your wind-powered device would be a viable alternative to a delivery device powered by fossil fuels? Explain.

Lab Activity Sheet 5

Worksheet—Design, Construct, and Evaluate a Wind-Powered Delivery Device

Part D: Performance evaluation

Evaluation criteria	**Rating**
Design of the device meets the rules and regulations set for the procedure.	_____
Design of the device is creative and unique.	_____
Presentation of the design drawing and description of the device is neat, accurate, and well organized visually.	_____
During the test, the device functions according to the rules and regulations set in the procedure.	_____
Note to the evaluator: Penalty points must be deducted if the device does not deliver the object 20 feet in less than 10 seconds.	
Lab clean-up and follow-up actions were satisfactory.	_____
Overall rating	_____

Evaluator's comments _____

_____

_____